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PAPERS AND PROCEEDINGS OF THE 15th ANNUAL MEETING

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HELD JOINTLY WITH THE UTAH MOSQUTIO ABATEMENT ASSOCIATION

Salt Lake City, Utah, April 12–15, 1959

PART I

THE MOSQUITOES OF UTAH—A Revised List [1]

LEWIS T. NIELSEN AND DON M. REES
Department of Zoology and Entomology, University of Utah

The first detailed report on the mosquito fauna of Utah was published by Rees (1943). In this bulletin Rees reported the occurrence in the state of 31 species, representing 4 genera, and discussed their biology, distribution, life history and importance.

Subsequent publications by Rees (1944), Rees and Nielsen (1951, 1955) and Richards *et al.* (1956) have added to the knowledge of the mosquito fauna of this state.

A total of 42 species has been reported in the literature as occurring in Utah. Of this number five are records which the authors consider invalid or of uncertain status.

Three species included in the present paper are new distributional records for Utah. Specific locality records, with dates and ecological notes are included for these species. Collections were made by the authors unless otherwise indicated.

At the present time the Utah mosquito fauna consists of 40 species representing 6 genera and is as follows:

Aedes: atropalpus (Coquillett), *campestris* Dyar and Knab, *cataphylla* Dyar, *cinereus* Meigen, *communis* (De Geer), *dorsalis* (Meigen), *excrucians* (Walker), *fitchii* (Felt and Young), *flavescens* (Müller), *hexadontus* Dyar, *implicatus* Vockeroth, *impiger* (Walker), *increpitus* Dyar, *intrudens* Dyar, *melanimon* Dyar, *nigromaculis* (Ludlow), *niphadopsis* Dyar and Knab, *pullatus* (Coquillett), *schizopinax* Dyar, *spencerii* (Theobald), *sticticus* (Meigen), *varipalpus* (Coquillett), *vexans* (Meigen).

Anopheles: earlei Vargas, *franciscanus* McCracken, *freeborni* Aitken.

Culex: apicalis Adams, *erythrothorax* Dyar, *pipiens* Linnaeus, *quinquefasciatus* Say, *restuans* (Theobald), *salinarius* Coquillett, *tarsalis* Coquillett, *territans* (Walker).

Culiseta: impatiens (Walker), *incidens* (Thomson), *inornata* (Williston), *minnesotae* Barr.

Mansonia perturbans (Walker) and *Psorophora signipennis* (Coquillett).

NEW UTAH RECORDS

Anopheles earlei Vargas. This species is apparently restricted to high mountain valleys in the extreme northeastern part of the state. Larvae were found in two localities; one at 7200 ft. elevation in a small, shallow, open, semi-permanent pond overgrown with grass and Carex plants. Larval associates were *Culex tarsalis* and *Culiseta inornata*. The other collection was at 6600 ft. elevation in a small, per-

[1] The studies on which this report is based were supported in part by grants from the University of Utah Research Fund.

manent, partially shaded woodland pool containing heavy growths of pondweed, *Potamogeton* species and rather densely covered with the duckweed, *Lemna minor* L. *Anopheles freeborni* larvae also occurred in this pond. Adults were found resting in culverts near both localities.—SUMMIT COUNTY: Chalk Creek, 7200 ft., V-15-56. RICH COUNTY: Woodruff Creek, 6200 ft., VI-11-53.

Aedes varipalpus (Coquillett). Larvae of this species were collected in tree holes of the cottonwood, *Populus fremonti* S. Wats, along the Virgin River in Zion National Park in southwestern Utah. Biting females also were collected in the vicinity. Identification of specimens as the true *varipalpus* was verified by J. N. Belkin of the University of California at Los Angeles.—WASHINGTON COUNTY: Zion National Park, 3900 ft., V-20-56, IV-25-58, III-23-59.

Culiseta minnesotae Barr. Specimens of this species were taken in two localities in mountain valleys of northern Utah. Larvae were collected in a small permanent overflow pool from a flowing well. The pool contained considerable algal growth. *Culiseta inornata* larvae also were present. —WEBER COUNTY: Weber River, 4500 ft., V-15-56; Huntsville, 4920 ft., VIII-24-56 (R. McHugh).

PUBLISHED RECORDS OF INVALID OR QUESTIONABLE STATUS

Anopheles quadrimaculatus Say. This species was reported from Utah by Howard, Dyar & Knab (1917). An examination of the Dyar collection of mosquitoes by Alan Stone in the National Museum has failed to reveal any *A. quadrimaculatus* material from Utah. No additional specimens of this species have been collected in Utah. The authors are of the opinion that Dyar's records are based on specimens of *Anopheles freeborni,* a very common species in Utah and one easily confused with *Anopheles quadrimaculatus.*

Aedes idahoensis (Theobald). Both *Aedes spencerii* (Theobald) and *Aedes idahoensis* (Theobald) were reported for Utah by Rees (1943). Since that time an examination of material referable to these species from the western United States has led the authors to conclude that only a single species complex exists. Therefore the prior name *A. spencerii* is used to refer to this species. This is in agreement with Pratt (1956) who also considered *A. idahoensis* to be a synonym of *A. spencerii.*

Specimens from Utah are generally similar to the form named *idahoensis;* however, material in the authors' possession from localities in northern Utah, Wyoming and Montana show a definite overlapping of characters of both forms in the adult female. In these areas some females show the typical *idahoensis* type of abdominal scaling with narrow to broad basal white bands on each tergite, and with few if any apical white scales. Other females, as is typical of *spencerii,* show a conspicuous dorsal median longitudinal stripe of pale scales or have the dorsum of the abdomen almost entirely covered with pale scales. Appreciable numbers of females, however, show almost every degree of variation between these two extremes. It should be noted that similar variations have been reported for *A. spencerii,* both in Minnesota, by Owen (1937) and in Wisconsin by Dickinson (1944). Dyar (1917) also reported an intergrading of *idahoensis* toward *spencerii* in the Missouri Valley of Montana.

Another difference reported in the literature to distinguish *idahoensis* and *spencerii* is the scaling on the posterior pronotum. In *spencerii* the scaling on the dorsal half of this sclerite is supposedly brown; in *idahoensis* white or whitish-brown. In the western United States the scaling on the posterior pronotum is so variable, not only in the areas of overlap, but throughout the entire Western States that it is worthless as a means of identification. Some specimens with typical *idahoensis* abdominal markings have typical *spencerii* posterior pronotal scaling. The reverse also occurs.

Unfortunately, insufficient larval mate-

rial is available from these intergrading areas to attempt an adequate correlation. Some larval specimens from northern Utah cannot be assigned with certainty, on the basis of the number of comb scales and comb scale structure, to either form.

The male genitalia appear to be indistinguishable not only in the intergrading areas, but throughout the entire ranges of both forms.

On the basis of collections in the possession of the authors and records available in the literature it appears that the *spencerii* type has a northern range in North America occurring in southern Canada and the northern United States while the *idahoensis* type is the form occurring throughout most of Montana, Idaho, Wyoming, Colorado and Utah. Intergrading areas appear to occur in parts of Utah, Wyoming and Montana. If the foregoing comments represent an accurate view of the geographical variation and distribution of the two forms it will be necessary to assign *A. idahoensis* as a subspecies of *A. spencerii*. It is interesting to note that Theobald (1903) described *idahoensis* as a variety of *spencerii*. Additional material, particularly from areas where intergrades occur, is needed before this problem can be adequately resolved.

Aedes punctor (Kirby). This species apparently does not occur in Utah. Specimens reported as *A. punctor* by Rees (1943) have now been assigned to *Aedes hexodontus* Dyar.

Aedes stimulans (Walker). This species apparently does not occur in Utah. Specimens reported as *A. stimulans* by Rees (1943) are actually *Aedes increpitus* Dyar.

Culex stigmatosoma Dyar. Dyar (1928) reported this species as occurring in Utah although no localities are given. Despite intensive collections throughout the state this species has not been collected again. The authors consider the presence of *Culex stigmatosoma* in Utah to be doubtful.

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MOSQUITOES AND MOSQUITO-BORNE DISEASES IN INDONESIA AND THEIR CONTROL

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INTRODUCTION. Indonesia, "The Isles of the Indies," was declared an independent nation by its people on August 17, 1945. For 350 years prior to this date, Indonesia was known as the Netherlands or Dutch East Indies and was governed as a Dutch colony. Today it is reported to have a population of some 82 million people. This establishes Indonesia, in population, as the sixth largest nation in the world. It is equally impressive in area as it includes approximately 3,000 islands and its boundaries extend from east to west some 3,000 miles and from north to south about 1,250 miles. Some of the larger islands in the archipelago are Sumatra, Borneo (Kalimantan), Java and the Sulawesi.

In origin, the people comprise several ethnic groups and it is reported that more than one hundred dialects were spoken when this country was founded. The island of Java, with its 52 million inhabitants, is one of the most extensive densely populated areas in the world, with an average of more than 1,000 inhabitants per square mile.

This country bordering both sides of the equator is a land of perpetual summer, generally with an abundance of precipitation, and a lush green vegetative cover. It is a paradise for mosquitoes, and, consequently, something less than a paradise for the human inhabitants. In this country of perpetual summer, with an abundant and varied mosquito population, which feed with impunity on the exposed masses of the people, certain mosquito-borne diseases not only occur, they are inevitable.

MOSQUITOES. Most of the scientific work on the mosquitoes of Indonesia has been done by Dutch scientists and the results have been published in the Dutch language. Surprisingly little work had been done by scientists of other nations in this fertile area prior to 1945. In recent years many of the more important publications on mosquitoes, that were originally written in Dutch, have been translated into English. Other references in this field are still available only in Dutch. No information on mosquitoes from the more remote regions of this extensive country is available, and only fragmentary information is available from any specific part of the country. At present the anopheline mosquito fauna is much better known than are the other mosquito groups, since the anophelines have demanded attention as vectors of malarial parasites.

There are some 98 species of anopheline and 248 species of culicine mosquitoes reported as occurring in Indonesia. As mosquito studies continue in this country it is inevitable that additional species of anophelines will be recognized and undoubtedly a great many additional species of culicines will be added to the list.

Most of the common species are generally distributed throughout the islands. However, there are a few species that seem to be confined to certain localized areas. Many of the common species are extremely abundant and persistent in their attacks on man and other animals. Mosquitoes are generally more annoying at night but in many areas in Indonesia certain species will attack during the day time. No organized attempt is made in Indonesia to control pest mosquitoes.

VIRUS DISEASES. Malaria and filariasis are the most common and important mosquito borne diseases in Indonesia. Dengue also occurs; yellow fever is not reported as being present and mosquito borne virus encephalitides have not been confirmed as occurring in this country, although a few cases diagnosed as encephalitis have been reported.

It is a mystery to medical science why

yellow fever does not not occur in Indonesia and associated areas in this part of the world. The climatic factors, the geographical position of the country, the abundance of the common mosquito vectors, and the presence of available human hosts that are apparently susceptible, make it difficult to explain why yellow fever is not present.

In the literature, a few isolated cases of encephalitis have been reported and most of them are clearly not the result of a mosquito borne virus. In the literature that was examined, there is no record of anything resembling an outbreak of mosquito borne virus encephalitides. This does not exclude the possibility that the disease is there and that outbreaks may have taken place. The difficulties of accurate diagnosis of this disease are well known to those who study these elusive viruses. The study of encephalitides in Indonesia is an open challenge at present. A modern and well equipped laboratory is available at the University of Indonesia for this purpose for anyone who would like to study these viruses in this country.

A disease, probably dengue, was first reported in Batavia (Djakarta) by van der Scheer in 1901. Since then dengue, or a similar disease has been reported in other parts of Indonesia, particularly on the islands of Java and Sumatra where more intensive studies of diseases of man have taken place. Both *Aedes albopictus* (Skuse) and *Aedes aegypti* (L.) have been reported as vectors of dengue in Java and Sumatra. These species are relatively abundant during certain seasons of the year in areas where dengue has been reported. Other species of mosquitoes that are recognized vectors of dengue are present in Indonesia and may be involved in the transmission of this disease. No specific mosquito control measures have been employed in the control of dengue or dengue-like diseases.

MALARIA. Malaria is the most important disease in Indonesia. The three types of malaria parasites present are: *Plasmodium vivax, P. falciparum* and *P. malariae*. The most common type appearing generally throughout the country is *P. vivax*. The other two types are more rare but are not uncommon in certain parts of the country.

Endemic malaria has been reported as occurring up to 5,000-foot elevations but more generally appears in the coastal areas and inland river valleys. The mortality rate for malaria in the low country of Java, before malaria control operations were established, is reported as 20/1000; in chronic areas 25–50/1000; and in epidemic areas as high as 400/1000. The spleen rate index in chronic endemic areas has been reported as high as 80–90 percent of the inhabitants examined.

The important anopheline vectors of malaria in Indonesia vary with the locality. The principal anopheline vector in the lowlands of western Indonesia is generally *Anopheles sundaicus* Rodenwaldt, and in the interior it is *Anopheles aconitus* Dönitz. Also reported as important vectors in certain specific areas are: *Anopheles maculatus* Theo., *A. hyrcanus* (group), *A. punctulatus* (group), and others.

The control of malaria in this part of the world has been recognized for centuries as the number one health problem. For many years anti-malarial drugs have been administered to suppress malaria in the human victims. Bed nets and insecticides have been used to protect man from the mosquito vectors. Even water management was attempted by the Dutch in some areas as a plan for source reduction of *Anopheles* mosquitoes and in certain areas larvicides were used as control measures.

Quinine was the first, and until recently, the most extensively used and produced anti-malarial drug in Indonesia. Quinine was regularly taken for many years by the Dutch and other people of Caucasian origin, stationed in or visiting Indonesia. The bitter quinine was frequently accompanied with a tall drink of gin presumably on the theory, if the gin did not disguise the taste of quinine the effect of the gin would make it easier to forget.

An extensive malaria control program

was started in Indonesia in 1955. It was sponsored by the Indonesian Government in cooperation with the United States International Cooperation Administration and the World Health Organization. At the end of 1957 some 17 million people in Indonesia were living in the area included in this control program. By 1957 the success of the malaria control program was evident in Indonesia as malaria had practically disappeared in the areas under control. In Djakarta, a city of some 3 million people where malaria was previously very common, new infections have become very rare. This was apparent from a study of the records of the Pediatric Ward of the 1,100-bed General Hospital connected with the Medical School in Djakarta. The chart (Figure 1) illustrates the decline of malaria in the children entering the hospital after 1955 when the control program was put into operation.

During 1958 an attempt was made to convert the malaria control program into a program of malaria eradication. The proposed general plan of the program of malaria eradication involves the treatment of all dwellings in a designated area once or twice a year with an effective residual adulticide. These treatments are to continue for three years, accompanied by a close surveillance of the area for an additional five years after the insecticide program is terminated. In this period of surveillance, if sporadic malaria appears it is to be eliminated with anti-malarial drugs.

The eradication program will be introduced into designated areas of the country as facilities are available, rather than into all parts of the country at the same time.

The results of the 1958 malaria program are not available for inclusion in this paper but continued progress has been made during the year.

FILARIASIS. Filariasis is widely distributed in Indonesia and the incidence in man is generally remarkably high and is frequently present in an individual without visible clinical symptoms. Both

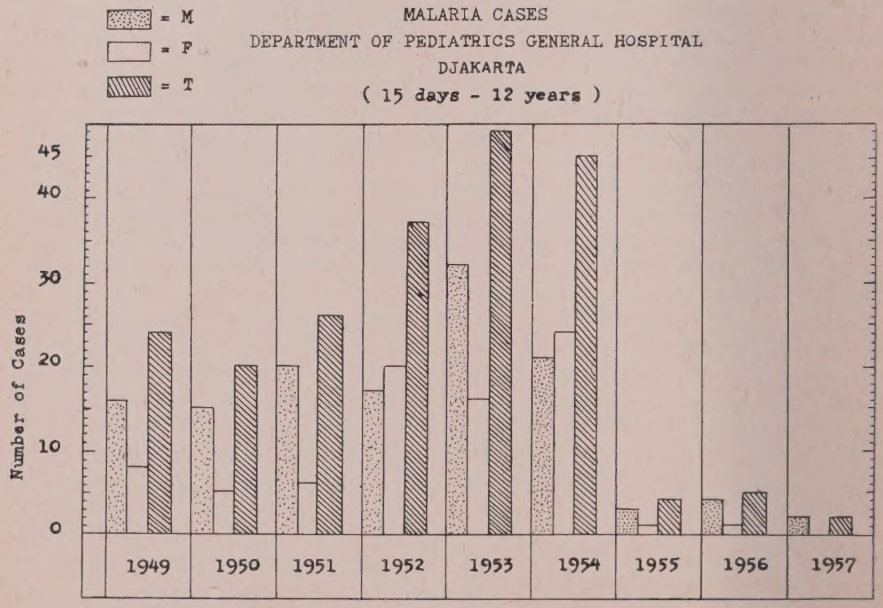

FIGURE 1

Wuchereria malayi and periodic *Wuchereria bancrofti* are present, sometimes in the same locality. Both species occur principally in the coastal regions and inland waterways.

Wuchereria bancrofti is more generally distributed in West Irian (New Guinea) and in other parts of eastern Indonesia. It appears more sporadically and less frequently on the more western islands. *Wuchereria bancrofti* is reported to be commonly associated with elephantiasis and hydrocele in West Irian and on the island of Buruh. In a recent extensive blood sampling and mosquito survey conducted in Djakarta by Dr. Lie, Kian Joe, and others, the incidence of *W. bancrofti* in 5,141 blood samples taken from man was 23 percent and of the 24,271 *Culex quinquefasciatus* Say (= *fatigans* Wied.) mosquitoes dissected during this survey, 1.8 percent were infected with *W. bancrofti* micro-filariae. Only one case of recognizable elephantiasis was located in Djakarta during this survey although hydrocele was common.

In Djakarta, *Culex quinquefasciatus* seems to be the principal vector, but in other parts of Indonesia other species of mosquitoes are reported with a high natural infection incidence: *Anopheles bancrofti* Giles, *Anopheles farauti* Laveran, *Anopheles punctulatus moluccensis* Swellengrebel, *et al., Armigeres obturbans* (Walker), *Aedes kochi* Dönitz, *Culex annulirostris* (Theo.), *Culex bitaeniorhynchus* Giles. Some fourteen additional species have been experimentally infected in the laboratory with *W. bancrofti* organisms.

Wuchereria malayi is more generally distributed throughout western Indonesia extending east to the island of Ceram. It occurs in rural areas and is frequently associated with elephantiasis of the lower extremities and recurrent lymphangitis. In a blood and mosquito survey conducted recently in Bengkulu, Sumatra, by Dr. Lie and others, in which 6,608 human blood samples were examined, 39.3 percent were positive for *W. malayi*. In a dissection of many thousand possible mosquito vectors during this survey, 1.4 percent were positive. In some of the villages surveyed, as high as 20 percent of the human adults had visible elephantiasis, and reports of lymphangitis were equally common.

The principal vectors of *W. malayi* are apparently species of the genus *Mansonia* including the following: *Mansonia annulata* (Leic.), *Mansonia annulifera* (Theo.), *Mansonia longipalpis* (Van der Wulp.), *Mansonia uniformis* (Theo.), *Anopheles barbirostris* Van der Wulp., (=probably *A. vanus* Venhuis), and *Anopheles venhuisi* Bonne-Wepster.

Three other species of mosquitoes have been reported as experimentally infected with *W. malayi*.

It is evident from recent investigations that filariasis constitutes an important health problem in Indonesia because of its high incidence and wide distribution. It is difficult to evaluate the disabling effects but the losses caused by filariasis in the efficiency of labor, man work days lost, and the care required for those suffering in advanced stages of filariasis and associated afflictions, create an enormous economic and social loss to the people of Indonesia.

The control of filariasis in Indonesia has not been attempted to date, although the more recent investigations of this disease by Dr. Lie and others represent the attempted beginning for such a control program. If malaria eradication succeeds, as expected, the control of filariasis in Indonesia will be next in importance as a mosquito borne disease. It is assumed that the equipment and trained personnel of the Malaria Eradication organization could then be employed for the control of filariasis. With this organization and the use of "Hetrazan" such a program might possibly become a program of "Filariasis Eradiction" rather than a program of filariasis control.

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FACTORS INVOLVED IN THE DEVELOPMENT OF RESISTANCE TO INSECTICIDES AND SOME MEASURES TO REDUCE ITS EFFECT

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The basic phenomenon in insecticide resistance is a change in the susceptibility of a population to the toxic effects of the chemical concerned. This change is not shown in the exposed generation but in succeeding ones. Attempts to demonstrate that the change is due to mutation(s), either caused by the chemical or occurring independently, have been uniformly unsuccessful so it may be concluded that with the materials at present in wide use, selection of a previously existing phenotype is the predominant mechanism. The development of resistance is thus an example of evolution in progress at a comparatively enormous rate with a chemical as the selecting agent.

The results of a selection usually are expressed in terms of the behavior of a population, as represented by the sample or samples tested, although the response is by individual insects. Therefore it is necessary to express the reaction of a group to a chemical in such terms as dosage required to knock down a given portion within a specified time, or to kill all individuals, or the time for death of a fraction to result from application of a certain dose, etc., etc. The simplest criterion to handle is mortality resulting from an increasing series of dosages, time being given for the full effect to develop but normal mortality being still low.

No group of individuals is entirely homogeneous and in the case of exposure to a chemical, the differences in susceptibility are represented by a dosage-mortality curve whose characteristic form is an elongated sigmoid. For different populations, these may vary greatly both in position and shape. Hence they are difficult to use in comparisons, especially quantitative ones. It is common practice to change to a linear form by a double transformation, giving the so-called ld-p lines, i.e., log dosage-probit or standard deviation lines. Not all dosage-mortality lines can be rectified, but most can, at least in the region of 50 percent mortality. Hence it has become the custom to compare populations or strains of insects in terms referring to 50 percent mortality, e.g., the LD 50, LC 50 or LT 50, in which the criterion is dosage, concentration, or time of exposure.

Figure 1, line A, shows a typical example. LD 50 = 0.42 and slope of line = 3.73, as measured by the mortality expressed in probits or standard deviations caused by a tenfold change in dosage (i.e., per one log unit of dosage). Now suppose 95 percent of the population are killed by a dosage of one unit of insecticide and the survivors give rise to a new generation. What will be its resistance? This is the problem with which plant and animal breeders have worked for many years in their selective breeding experiments and no simple answer is possible. It is helpful to show the ld-p line for the survivors of the treated generation. Since in the present case only one in twenty survived, the survivors at each dosage above the LD 95 will contribute twentyfold to the breeding population. Thus at dose 1.2, the mortality would be (97.7–95) x 20 = 55 percent. Other points on the resulting line B are calculated similarly. This ld-p line *for the survivors* will hold for their progeny only under the special condition that all genetic factors for susceptibility have been eliminated from the population and the breeding group is homozygous for resistance.

In any actual case, genes for resistance will occur in both heterozygous and homozygous individuals and when they are rare

the great majority will be in the heterozygotes. In the next generation these will give rise to some individuals homozygous for susceptibility as well as others heterozygous and homozygous for resistance. Numerical calculation is possible only when the composition of the original population and of the survivors is known in terms of frequency of the genetic factors. It will be clear, however, that if all individuals lie on the ld-p line A, then the line for the next generation must lie between A and B, perhaps as shown for line C. If selection had been made at the 99 percent level, the line for the next generation would have been steeper and slightly more to the right. Repetition of selection would result in successively smaller changes and the population would become highly homogeneous.

It is obvious that from a population originally relatively homogeneous, as indicated by a steep ld-p line, and *whose members all fall on the line,* it is not possible to obtain a highly resistant strain. This situation appears to be the case with numerous species which fail to develop resistance under even intensive selection.

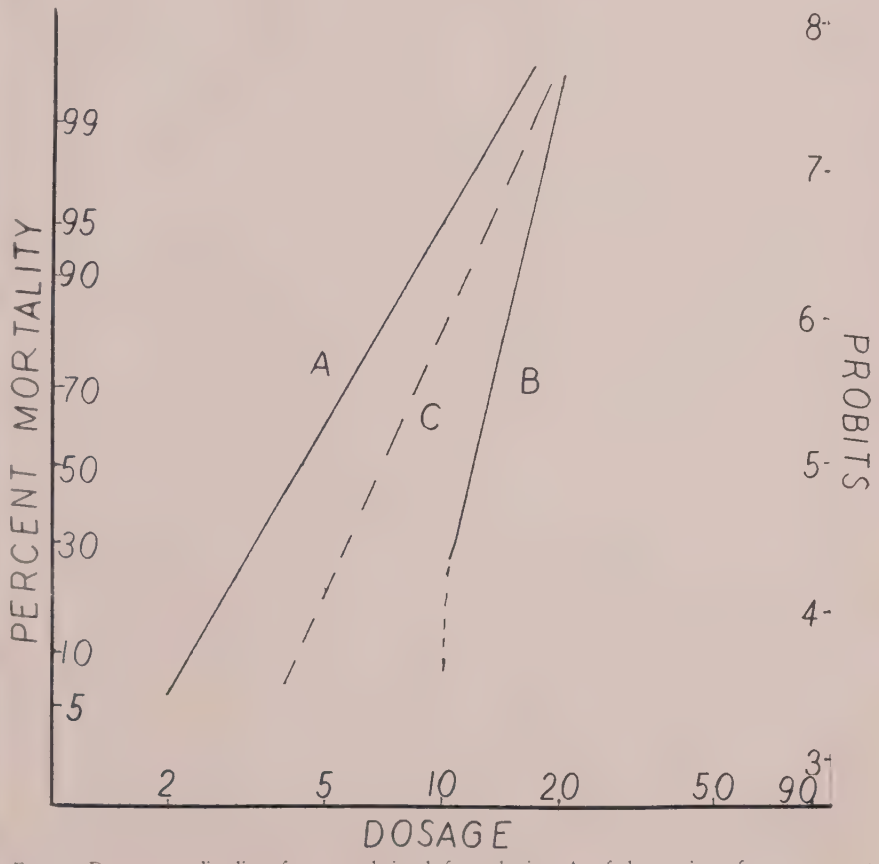

Fig. 1.—Dosage-mortality lines for a population before selection, A; of the survivors from 95 percent selection, B; of next generation, C.

The relatively small increase in resistance achieved may be caused by exposure to any unfavorable condition, for only the weaker members are lost. Hence this type of resistance has been called vigor tolerance. Many instances have been recorded in the literature. A typical one is the finding by Hawkins (1956) that in a colony of *Anopheles quadrimaculatus* the larval LD 50 changed during selection with DDT from 2.6 ppb to 7.0 ppb in five generations. During this time the upper limit of the more tolerant individuals did not change appreciably but the frequency of the very susceptible ones decreased notably.

In contrast, suppose that at the upper end of the ld-p line there are individuals more resistant than corresponds to any position on the line, as represented by points along the line a′-b in Figure 2. Let selection now be made at the 95 percent level and the composition of the survivors calculated as before. The result is line A-B which is often no longer straight. For the same reasons discussed in case of Figure 1, the generation coming from these survivors will give an ld-p line lying be-

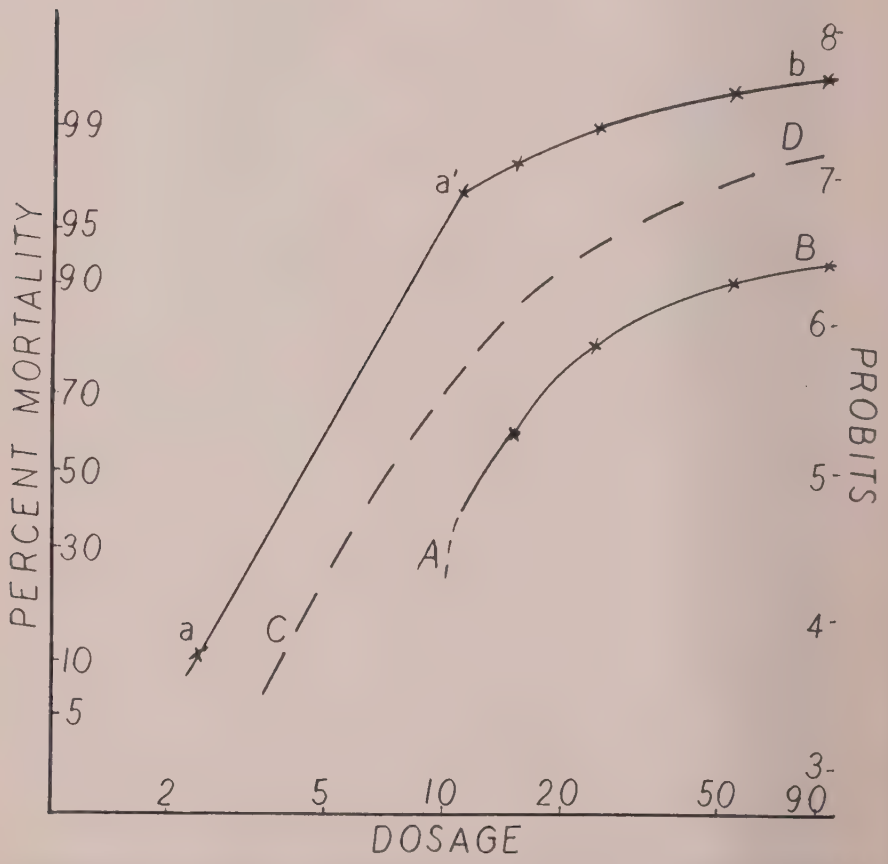

FIG. 2.—Dosage-mortality lines for a population having individuals off the straight ld-p line, a-a′-b; of survivors from 95 percent selection, A-B; of next generation, C-D.

tween lines a-b and A-B, e.g., such as C-D. This situation differs from the former one, however, in the very important point that since the original population was not restricted to a *straight* ld-p line, the succeeding generations will move increasingly to the right and reach a level of resistance determined chiefly by the most resistant individuals in the population before selection began.

It will be obvious from the foregoing discussion that the prime prerequisite for development of specific resistance under pressure from an insecticide is the presence in the population of certain individuals carrying in their genetic makeup the character or characters that cause resistance. These may be an enzyme that detoxifies the insecticide, abnormally impermeable integument or gut wall, extra fat that acts as a trap for absorbed insecticide, etc., etc. In any species controllable by a given chemical such individuals and their peculiar genetic characteristics are rare. The problem of determining if resistance can arise, before there is any practical evidence of it, is then to detect a rare property in the population.

If insecticide resistance should be associated with some visible character such as darkening of the integument, even close examination of many individuals would be feasible in order to detect the rare ones having this peculiarity. Unfortunately no such simple associated marker has been found except in special cases, in which the association appears to be by chance (Wiesmann, 1947; Bigelow and LeRoux, 1954). As yet, the only method for detecting resistant individuals is use of increasing dosages. If they are very rare it will be impossible to be certain that any are present, for no testing method is completely efficient. It cannot be emphasized too strongly that large populations must be used. In small groups the rare resistant individuals may be totally absent though heterozygous individuals carrying recessive genes for resistance may be present. For similar reasons, laboratory strains derived from a few ancestors are certain to lack many characters present in field populations because a small group cannot typify the whole species.

Several situations may be distinguished. If a population before use of a certain insecticide has a steep ld-p line, e.g., 3.5 or greater, and no individuals lying off the ld-p line at high dosages are found in groups of several hundred individuals, it is safe to conclude that at the worst, resistance will be very slow to develop and the effects of vigor tolerance will not make use of the chemical impractical. If the original ld-p line is rather flat, say having a slope of 2, but again all individuals seem to be upon it, the effect of control measures will be to raise the LD 50 a few fold only. On the other hand, if even a few individuals lie to the right of the ld-p line, that is sure evidence that genuine resistance can be developed, the degree depending upon how resistant these aberrant individuals are.

With a population under pressure from an insecticide, the customary procedure is to look for changes in the LD 50, or better, in the LD 90 or 95, as use of the chemical continues. If the population shifts toward a higher proportion of less susceptible individuals, because of removal of the more susceptible ones, the result is a decrease in slope. There is an increase in LD 50 and a greater increase in LD 90. It must be noted that this can result only from individuals lying to the right of the original ld-p line, for as noted earlier, in the absence of such individuals, elimination of the weaker ones *increases* the slope of the line. This is the reason for regarding a flattening of the ld-p line as sound evidence that resistance is developing. (Hoskins & Gordon, 1956.)

When resistance has developed to the level that an appreciable number of the treated insects are surviving and the damage characteristic of the species is occurring, the question arises of what units should be used to express the resistance. No single answer is possible. To take an extreme case, with red scale and hydrogen cyanide, control of at least 99 percent was

needed in order to forestall serious damage to citrus. Hence the dosage (expressed in various terms) necessary to secure 99 percent mortality of scales at the optimum stage for control procedures was used as a measure of the resistance. For most agricultural pests and for insects of medical importance such high control is not required. Also very large numbers must be available for this level to be determined with accuracy. The LD 50 is not a good measure, for ordinarily considerably over half the population must be killed if the control program is to be useful. Consequently it is common practice to use the dosage for 90 or 95 percent mortality. Since the ld-p line steadily becomes flatter in the early stages of resistance, the dosage for this high mortality increases rapidly and significant differences are obvious by mere inspection. The slope should be included in reporting on tests for resistance since the whole ld-p line is determined by the slope and one dosage-mortality point. Even slight differences in the test method used often cause marked changes in the apparent relative susceptibilities of different strains. Comparisons then are meaningless. For this reason the work of the WHO in introducing and popularizing standard techniques for use with mosquitoes, lice and other insects of medical importance is extremely valuable. Unfortunately, standardization of testing methods for agricultural pests has made little progress.

It sometimes happens that severe selection brings the proportion of highly resistant insects to such a high level that mortality cannot be driven beyond a certain percent regardless of the dosage, i.e., the ld-p line tends to become flat. In such cases it is not possible to determine the LD 90 or 95 and the best expression of the resistance is the dosage beyond which further mortality is slight.

While detection and measurement of resistance are important, for purposes of long-range planning, prediction of the effect of proposed control programs is of prime interest. Some typical questions are:

(1) Can a satisfactory level of control be obtained without resistance soon making it impractical?

(2) Can sources of infestation from untreated areas offset the selection process?

(3) If use of a chemical is stopped before it becomes useless, will it be of value again after a waiting period?

(4) In case control may be applied at different stages of the insect's life cycle, how can a choice be made to minimize development of resistance?

(5) Will use of combined chemicals bring on resistance to the combination more rapidly than if they are used alternately or in sequence?

(6) Should chemicals that are highly toxic to predators and parasites be avoided no matter how effective they are against a pest species?

Doubtless many other similar questions will come to mind.

Satisfactory answers can be given to few such questions since the circumstances in particular cases often have decisive effects. One general guide is that the more severe the selection in the field, the more rapidly resistance will come on and the higher it will reach. This is not necessarily true with populations of limited size such as laboratory colonies, for if only a very few survivors are left to propagate the next generation, these may lack various genetic factors making for normal rate of growth and fertility. Whenever resistance is a rare property it is associated with some biochemical or physiological behavior that is unfavorable, such as the longer larval life found in houseflies. When natural tolerance is marked, the factor(s) for resistance is either neutral or even favorable for growth and reproduction. Natural tolerance is by no means rare for it occurs in case of any species which cannot be killed by the dosages used in control of other species. Thus grasshoppers in general are tolerant toward DDT and among mosquitoes, *Culex fatigans* is considerably less susceptible than related species (Wharton, 1951).

From the facts that severity of selection controls the rate at which resistant indi-

viduals become concentrated in the population and that resistance is a biological handicap, it follows that at least in theory a level of control can be maintained if properly set in the first place. Whether or not this is satisfactory from an agricultural or medical standpoint is determined by other factors. It might mean that the public would have to be satisfied with a lower quality of foodstuffs and learn to tolerate a few mosquito bites. The present attitude of the Food and Drug Administration against even a few insect parts in or on foods is incompatible with development of this idea.

The point just discussed is related closely to the matter of how intrusion of insects from untreated areas will affect development of resistance. In any practical control program some insects escape contact with the insecticide or receive a dose insufficient to prevent normal breeding. These then dilute the selected group and if further dilution occurs from outside, the breeding stock will contain a considerable fraction of susceptible individuals. To put this semi-mathematically, consider that the 5 percent survivors shown by curve A-B in Figure 3 (repeated from Figure 2) are joined by an equal number from outside having the same susceptibility pattern as the original population in the treated area. By adding the contributions from the two groups the discontinuous solid line DEF is obtained as the ld-p line for the parents of the next generation. With individuals homozygous for susceptibility now present in the breeding group it is obvious that the ld-p line, c-d, for the next generation will move farther to the left, largely overcoming the effect of selection. This is especially likely to occur with nonpersistent insecticides. It is possible to calculate the fraction that must move into a treated area (or simply escape contact with the chemical) in order to maintain a level of susceptibility but little different from that prevailing in the absence of treatment. If this happens to be within the tolerable control range, a situation very favorable for long-continued use of the insecticide is at hand. It often has been suggested that untreated areas be left in order to prevent or delay the development of resistance. The equivalent of this is spot treatment instead of area-wide application, as sometimes is done in fly or mosquito control. Even the rearing of a susceptible strain and liberation at a time when they would do least harm is not beyond reality in some cases.

All long range programs for insect control through chemicals should have as a basic consideration, the tendency of practical populations to revert toward their original condition whenever the pressure from an insecticide is lessened or withdrawn. It may happen in laboratory strains that heterozygotes are eliminated by strenuous selection so there are left only individuals homozygous for resistance. These are characterized by a steep ld-p line and inability to regress unless more susceptible individuals get into the colony from outside or, more rarely, an appropriate mutation occurs. But field populations will always contain individuals carrying genes for susceptibility and it is of practical interest to inquire if cessation of insecticide treatment for a time or use of a chemical having an entirely different mode of action, will enable a genuinely fresh start to be made.

Perhaps the best studied example of reversion in a large field population are house flies in Denmark where DDT was discontinued in 1949 when it was no longer effective. After six years in which chlorinated hydrocarbons were not employed, only a few percent of the flies were still resistant to DDT or chlordane (Wichmand, 1956). A similar sequence occurred with house flies in Southern California after intensive use of DDT and other chlorinated hydrocarbons was stopped in 1952. A very disturbing phenomenon has been observed upon reapplication of an insecticide to field and laboratory populations which had regressed from resistance. Thus in Denmark it was found that after two applications of DDT the field population of house flies once more was nearly all resistant. At first sight this would seem to mean that the resistance came

about the second time through a different mechanism than that operating during the first use of DDT. However, the Danish flies separated sharply into susceptible and resistant individuals as shown by the ld-p line which had an almost horizontal portion in the central range of dosage. This probably signifies that many resistant flies were homozygous. Since the fraction of resistant individuals decreased during relaxation of DDT use only to 5–10 percent of the population, it is to be expected that upon reapplication, the homozygous individuals producing only resistant offspring would very quickly predominate. If the initial low fraction of resistant flies had been fully reached there is no reason to doubt that as long a period of use would have been possible as during the first years of control. The moral seems to be: use of a chemical must be stopped when resistance is still at a low level or an excessive period of recovery will be required to restore the original susceptible condition.

One further point may be mentioned in

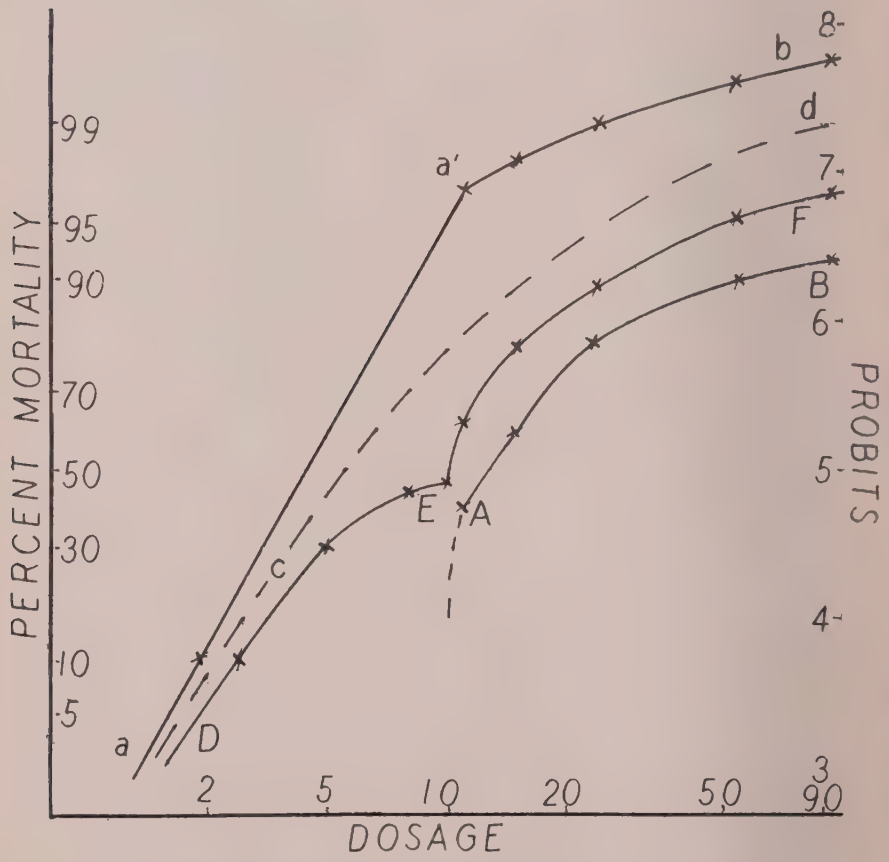

FIG. 3.—Dosage-mortality lines for a population having individuals off the straight ld-p line, a-a'-b; of survivors from 95 percent selection, A-B; of these survivors plus an equal number from original untreated population, D-E-F; of next generation, c-d.

connection with this matter. In the previous discussion there was no occasion to inquire whether resistance is due to one or to several factors. When one, such as the dehydrochlorinating enzyme of house flies, is the controlling factor, the genetic situation is relatively simple and the classical crossing tests may be made with susceptible and resistant strains to test for dominance, sex-linking, etc. And if the factor is either strongly dominant or recessive, it is possible to separate a population into two groups by use of a discriminating dose which kills all susceptibles and leaves all resistant ones. This is the case with the house flies studied by Keiding in Denmark (Wichmand, 1956). But if a number of biochemical or physiological processes are concerned to a significant degree in resistance, their effects enter to varying extents in different individuals and sharp separation into groups is impossible. Another point is that in the original susceptible population individuals will have a mild resistance because of any one of the factors, but no one insect includes them all. During selection, as resistant individuals contribute genetic material to their offspring, these isolated factors tend to congregate and eventually individuals are produced containing several of them. When this linking of resistance factors has once occurred, the level will be higher than in the original colony. Under this situation it is no longer true that resistance only approaches that of the most resistant individual in the original colony. Also such highly resistant individuals will reproduce their kind and some will survive during periods of pressure relaxation. Under renewed exposure they can very quickly make up a significant part of the population since the long delay associated with bringing the various factors together is not required. This doubtless is the reason why resistance is quickly restored in some insects, e.g., roaches (Fisk & Isart, 1953).

The success of insects as a form of life is due in large measure to their enormous reproductive potential. Dr. L. O. Howard once estimated that from a single pair of house flies starting in the springtime a total of 1.9×10^{20} progeny might be produced by fall—sufficient to cover the earth to a depth of nearly fifty feet. It is obvious that in this as in other cases an enormous natural mortality occurs. Chemicals make only a slight further reduction in numbers. It follows that development of resistance may be lessened if they are in such a manner and at such a stage that the *chemical selection* is at a minimum. As an example, take flies or mosquitoes which may be controlled either in the larval or adult stage. If 95 percent larval mortality is secured by a chemical, the survivors after undergoing natural mortality will give a certain permissible adult population. On the other hand, a certain treatment of adults will reduce the population to the same level. In either case the parents of the next generation will have survived exposure to the chemical and it might appear that the situations are identical with respect to development of resistance. But there are at least two differences. With no application to the adults there is more chance for intrusion of outsiders and consequent diminution in the rate of resistance development as discussed earlier. On the other hand, in early larval treatment there is no sexual discrimination and hence surviving males and females will in general have equal resistance factors. But adult treatment eliminates all but the most resistant males which then transmit this strong factor to their progeny. The two effects seem to work in opposite directions. It is unfortunate that this and similar theories have not been checked as yet by quantitative study of larval versus adult selection with recognition and proper control of the numerous conditions affecting the results.

Any consideration of the relative roles of natural and chemical control should take account of parasitic and predatory arthropods which in many cases are the chief destructive agents. These are subject to the action of insecticides to varying degrees, but some classes such as Hymenoptera and Diptera are very susceptible to most insecticides. In numerous instances

destruction of the beneficial species by a chemical of wide effectiveness, such as parathion, has resulted in a regular outburst of pests after the effects of the chemical have worn off. The moral here is to use chemicals in such a manner and at such a time that the beneficial species are damaged as little as possible. Fortunately this principle is receiving increasing attention in modern economic entomology. A good example is the cooperative program between agricultural entomologists and biological control specialists in suppression of the spotted alfalfa aphid in California. Chemicals are considered as emergency weapons to be used only when natural control is inadequate, as early in the growing season or in any region before enemies of the aphid have become established. There doubtless are numerous situations in medical entomology in which the same principles are applicable.

The foregoing discussion has been concerned with what might be called a negative approach to resistance, i.e., methods for delaying its onset. It is of interest to consider the positive aspect—how to reverse the development without abandoning the responsible insecticide. The most obvious method is use of a second chemical. Synergists are materials of little effect by themselves but potent in restoring the effectiveness of an insecticide to which resistance has developed. A considerable number have been found for DDT. Most are structurally related to DDT but the first one, piperonyl cyclonene (Perry and Hoskins, 1950), is also a pyrethrin synergist of no obvious relation to DDT. Experience to date is that resistance to the combination develops after a period of use when it is employed widely and there seems to be no reason to believe that synergists can have more than a transient role in the resistance problem.

Simultaneous use of two insecticides having different modes of action has been suggested on the theory that resistance to one would not lessen the effectiveness of the other and hence resistant individuals would continue to be killed by the combination. This can at best only delay development of resistance and it is of interest to inquire whether the period of usefulness of the two materials used together would differ from the sum of their two periods if used in sequence. Crow (1952) has given calculations indicating an advantage for use in sequence. The calculations are based upon the assumption that the populations remain normally distributed in respect to susceptibility. The fact that the ld-p line becomes far from straight, as discussed earlier, is a consequence of the population departing widely from normality and hence these calculations cannot be valid for actual cases. At present there is no answer to the question and in any event, the final result is a condition of multiresistance which already is characteristic of insects in many parts of the world.

Addition of a second insecticide on the theory that what one misses the other will kill, is sound theoretically only if the second material is more toxic to resistant individuals than to susceptible ones. This idea has prompted several laboratory investigations aimed at effecting this "inverse selection." Mitlin *et al.*, (1956) found that among a series of chlorinated hydrocarbons of the general formula $(RO)_2P(O)OC(HCl)CCl_3$, the isopropyl compound was more toxic to DDT-resistant house flies than to sensitive ones by nearly threefold. Later Kearns (1957) exposed a fly population originally containing only 5 percent DDT-susceptible individuals to this chemical and in three generations obtained a susceptible population.

Following the discovery (Ascher and Kocher, 1954) that a Swiss strain of highly DDT-resistant house flies was knocked down more quickly than a susceptible one by alkali bromides administered orally, Ascher (1957a) tested bromo-, chloro- and iodo-acetic acid and certain esters by tarsal contact against DDT-resistant and -susceptible strains of *M. domestica* and *M. vicina*. The R strains were knocked down more quickly by cetyl

bromoacetate and certain other compounds showed a more rapid toxic action to the R *vicina* than to the S strain. This work was further elaborated with tests against house fly strains selected by exposure to diazinon, chlordane or chloroacetic acid (Ascher, 1958). In all cases the knockdown by cetyl bromoacetate was about 50 percent more rapid with the resistant strain.

Another example of reverse selection was discovered by Ogita (1958a) who found that addition of phenylthiourea at the rate of 5 millimolar solution to the larval diet of several races of *D. melanogaster* suppressed the emergence of DDT-, BHC- and parathion-resistant strains but not of susceptible strains. With phenylurea the opposite result was obtained since emergence of susceptibles was completely suppressed by 50 millimolar solution which had little effect upon the resistant strains. For practical application Ogita (1958b) made a mixture of DDT and phenylthiourea in which the DDT was just effective against PTU-resistant individuals and the PTU was just effective against DDT-resistant individuals resulting from a cross of a DDT-resistant and a DDT-susceptible strains.

Cole and Clark (1959) have attempted to reduce the resistance of a DDT-resistant strain of body lice by selecting for breeding those individuals which were knocked down first by the compound 3-*p*-chlorophenoxy-1,2-propane oxide. After 20 selected generations there was no diminution of the resistance to DDT. However, it was not shown that this compound has a greater effect upon R than upon S individuals so this work really was not based upon the principle of inverse selection.

Instead of attempting to find a chemical effective in killing resistant insects, the same purpose may be served by one which lessens reproduction. Thus Ascher (1957a) found that female house flies, both susceptible and resistant, laid fewer eggs if they were allowed to walk on a deposit of di(*p*-chlorophenyl)-trifluoro methylcarbinol or the corresponding pentafluoro ethyl compound before being given milk to drink. Since live spermatozoa were found in the spermatheca and the ovaries were developed, this appears to be a case of forced retention of eggs. Similar experiments with female *Aedes aegypti* mosquitoes also resulted in lowered egg deposition. In this case contact was with the compound on filter paper for 30 minutes followed by 24 hours without food before a blood meal (Ascher, 1957a). There was no effect on longevity or feeding.

In these experiments of Ascher with house flies and mosquitoes no greater effect was found upon resistant than upon susceptible strains and hence the effect has no tendency to undo the resistance. But in certain experiments of Hunter *et al.*, (1958) DDT-susceptible and -resistant female flies were treated with sublethal amounts of diazinon to which each strain was susceptible. The estimated potential adult offspring per female (based on number of egg clutches, number of eggs per clutch, percent fertility, survival to adult stage and percent of resulting females laying eggs) was 78.5 percent of normal in the resistant strain and 101 in the susceptible strain, which therefore was favored to increase in an exposed mixed population.

It should be noted that none of the various procedures to reverse selection have been tried with populations under natural conditions and hence their practical value cannot be even estimated.

This brief review of insecticide resistance has ignored many important subjects and passed over others too lightly. It has not been directed especially toward mosquito control problems since these are being discussed by experts in the subject. If any special lesson is to be drawn, perhaps it is this: all living organisms are naturally in a dynamic balance of incredible delicacy. Any act that disturbs this balance will bring a reaction, for Nature has many resources. Man's alterations had best be made with a pointed spear which touches the desired area as lightly as possible rather than with the broadsword which cuts a heavy swath through the whole vicinity.

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MOSQUITO CONTROL ACTIVITIES IN THE COLUMBIA BASIN, WASHINGTON, FOR 1958

HARRY G. DAVIS [1] AND HARRY H. STAGE [2]

For the past several years, increasingly larger numbers of mosquitoes resulting from expanded irrigation in the Columbia Basin not only created a serious nuisance but also added the threat of an encephalitis outbreak. Because the community of Moses Lake became alarmed as a result of publicity concerning these threats, particularly with the prospect of an early hot season, some public spirited citizens contacted the Washington State Department of Health for technical advice and direction. The junior author was called into consultation at which time he outlined a budget and control procedures.

As a community project, a small group of women organized a door-to-door fund raising solicitation. Within three days, they had raised $10,685.19. Shortly thereafter, at a community rally, the Moses Lake Mosquito Control Authority was formed.

Initiation of the control program started with the city's division into four sectors, and a carefully selected energetic young man was placed in charge of each of them. After a short training session the men immediately assumed their duties in the field and were placed under the supervision of the manager of the Moses Lake public works department. The combination was a fortunate one, and from the beginning, their efforts produced favorable results.

Control efforts were directed at the breeding source, with applications of a 5 percent DDT oil solution used at the rate of up to three gallons per acre, the concentration depending upon the kind and extent of vegetational patterns. In certain instances "Tossits" were used effectively.

Whenever adult mosquitoes migrated into the treated areas they were controlled

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by DDT fogging applications. This was necessary on several occasions especially after northeast winds had prevailed. As the season progressed, larviciding was extended beyond the original three-mile limits from the center of the city. This extension of boundaries became necessary because of the concentrated breeding sites found in seepages along ten miles of Crab Creek which borders the northeast sector of Larson Airforce Base. Because of the mutual problems and the close proximity of the untreated Crab Creek areas to the base as well as to the city, Larson Airforce officials greatly aided the control program with generous donations of material, equipment and manpower. Considerable amounts of DDT and several experimental larvicides were contributed by the California Spray Chemical Corporation and Dow Chemical Company.

Hoof prints along the margins of the Crab Creek seepages proved to be ideal breeding sites for *Culex tarsalis*. Although these were easily controlled, the magnitude of the area necessitated an arduous effort.

The principal problems of mosquito control which confronted the control authority were breeding sites within the city or adjacent areas, including drainage ditches clogged with dead Russian thistle which provided shelter and protection from the larvicides, high water temperatures which resulted in shorter life cycles of the mosquitoes as well as reduced effectiveness of the larvicides, and occasional influxes from marginal areas of large populations of adult *Aedes dorsalis*. Goat Island, a large sedge- and cattail-covered island lying near one of the principal housing centers in the city, proved to be especially difficult to control. Aerial dispersion of DDT was found to be quite costly and relatively ineffective due to the heavy vegetation. Burning the vegetation on the island was somewhat helpful.

Because of a history of repeated adulticiding of Larson Airforce Base proper by aerial applications of DDT, the question of resistance was raised. However, tests conducted by the State College of Washington Department of Entomology proved that resistance had not developed.

A great deal of information concerning the day to day progress of the control program was published by the local press. Also, interesting public releases, stories and coverages were broadcast by the radio and television stations of the area.

At the end of the breeding season a concentrated effort was made to acquaint the public with advantages of an organized mosquito abatement district. This was done by presenting a series of talks and showing moving pictures and slides to civic clubs and organizations. Apparently the season's demonstration as the first community-organized mosquito control project in the Columbia Basin section of the State of Washington was accepted, because the formation of the Moses Lake Mosquito Control Abatement District was approved by the vote of the citizens.

DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT

8130 Ogden Avenue, Lyons, Illinois

Member of American Mosquito Control Association

Trustees

Otto McFeely, President; Charles F. Scheel, Vice-President; John J. Callahan, Secretary; Francis P. Creadon, Treasurer; William E. Goersmeyer, Ass't Secretary.

Franklin C. Wray, Technical Director

The District was created under state law adopted in 1927 by the General Assembly of Illinois. The District has functioned for thirty-two years.

CURRENT EFFORTS IN MOSQUITO CONTROL IN HAWAII

PATRICK Y. NAKAGAWA AND JOHN M. HIRST
Bureau of Mosquito Control, Department of Health, Honolulu, Hawaii and Commander, USN, PMU #6, Pearl Harbor, Hawaii

What we are about to say may alienate us with our Visitors Bureau for we are about to admit that even in the Paradise of the Pacific we are bothered by mosquitoes. In the same breath, however, we would like to restore harmony by stating that we in Hawaii have to contend with only three species whereas Florida and California boast about their approximately 70 and 40 species, respectively.

Actually, mosquitoes are recent immigrants to Hawaii. The first species to establish itself was the night mosquito, *Culex quinquefasciatus*.

Van Dine (1904) states: "Previous to the year 1826 mosquitoes were unknown in Hawaii. During that year they were brought to the port of Lahaina, on the island of Maui, in the ship 'Wellington' from San Blas, Mexico." The exact dates of the introduction of the remaining two species are not established, but according to Usinger (1944), "*aegypti* was widespread in Hawaii when Perkins [1] started his collection for Fauna Hawaiiensis in 1892, whereas *albopictus* 'did not come to notice' until 1902." Subsequently, over the past 57 years there has been no further successful introduction of noxious mosquitoes into Hawaii. Potentially, however, there always exists the threat of new introductions. According to U. S. Public Health Service record in Hawaii from 1939 to March 1959, 46 species [2] have been recovered from aircraft arriving in Hawaii. In October 1958, a mosquito specimen recovered during the routine check was found to be *Culex tritaeniorhynchus*, the primary vector of Japanese B encephalitis.

The Hawaiian Archipelago is a group of islands, reefs and shores strung out from southeast to northwest for 1,600 miles between 150°40′ and 175°75′ w. longitude and 18°54′ to 28°15′ n. latitude. Generally speaking, however, the Hawaiian Islands are limited to a group of eight islands totalling 6,430 square miles and include, in order of their sizes, Hawaii, 4,030 square miles; Maui, 728 square miles; Oahu, 604 square miles; Kauai, 555 square miles; Molokai, 260 square miles; Lanai, 141 square miles; Niihau, 72 square miles; and Kahoolawe, 45 square miles. The total population of Hawaii, the 50th State, numbers 585,025; the distribution by islands being as follows: Hawaii, 62,464; Maui, 36,600; Oahu, 449,910; Kauai, 28,035; Molokai, 5,506; Lanai, 2,267; and Niihau, 243. The island of Kahoolawe is unpopulated.

The climate of Hawaii is mild and temperate and relatively free from any uncomfortable extremes. In Fahrenheit readings the maximum is about 90° and the minimum about 55°. The annual average is about 70° in downtown Honolulu with a daily range of about ten degrees between the low and the high. The average temperature on Oahu decreases with the elevation but up to over 1,000 feet the extreme maxima are higher and the extreme minima are lower than in downtown Honolulu, and in residential sections a few miles inland the daily range is several degrees greater. As to rainfall, the average amount in the city of Honolulu is less than 25 inches per year. However, progressing inland from downtown Honolulu toward the mountains there is a rapid increase to an annual average rainfall of over 50 inches within a radius of two miles; one mile further inland, the average is from 90 to 100 inches. In general, the mosquito breeding index increases in direct proportion with the rainfall and

[1] Perkins, R. C. L. 1913. Fauna Hawaiiensis, Introduction. Vol. I, Pt. 6, p. clxxxi, University Press, Cambridge, England.

[2] Personal communication with Dr. Charles R. Joyce, Medical Entomologist, USPHS, Quarantine Branch, Honolulu, Hawaii.

hence, it is not unusual to encounter conspicuous fluctuation in breeding indices in areas separated by a mere mile or two.

The three species of biting moquitoes in Hawaii are *Aedes aegypti, Aedes albopictus* and *Culex quinquefasciatus.* The two *Aedes* species because of their daytime biting habit are referred to as the day mosquitoes; the *Culex* species, on the other hand, bites during the night and is commonly called the night mosquito. All three species are notorious vectors of human diseases. Fortunately, however, dengue is the only mosquito-borne disease which has occurred in the Islands in epidemic proportions. Significant outbreaks have occurred in 1903, 1912, and 1943–44. To summarize the disease transmitting potential, all three species have been shown to be natural or experimental vectors of the following diseases:

Aedes aegypti: Yellow fever, dengue, filariasis and encephalitis.

Aedes albopictus: Dengue, yellow fever and encephalitis.

Culex quinquefasciatus: Filariasis and encephalitis.

From the standpoint of control, the night mosquito, *Culex quinquefasciatus,* is today the only serious mosquito pest which is currently demanding organized control effort. In the past, however, emphasis was on the *Aedes* species. In fact, the Bureau of Mosquito Control, Department of Health, owes its origin to these two day mosquitoes. It was created as a unit under the Department of Health in 1946 as an outgrowth of the dengue outbreak of 1943 for the specific purpose of keeping these two vectors of dengue fever under control. Today, with continuing control maintained through systematic house-to-house inspections, the *Aedes* species appear to be well under control in the city of Honolulu as reflected in a ten-year average breeding index (1949–1958) of 2.5 percent. This general city-wide average index represents a range in variation in the breeding indices from an average of 0.5 percent in the drier part of the city with approximately 20 inches of rainfall to a high of 9.7 percent in the wetter districts with 60 inches or more rainfall a year. Concerning the status of *Aedes aegypti* in Hawaii, surveys conducted by the Bureau of Mosquito Control on the island of Oahu have failed to uncover the presence of this species since about 1949. Also on Kauai *aegypti* has not been observed since its last record of observation in leeward Kauai by D. D. Bonnet in 1945 (Hess, 1957). It is still present, however, on the neighbor islands of Hawaii, Maui and Molokai.

In Hawaii, the breeding habits and characteristics of *Culex quinquefasciatus* appear to vary from that of the domestic house mosquito to those of irrigation, floodwater or salt-marsh mosquitoes. This foul-water species breeds in a great variety of water-holding containers including tin cans, buckets, barrels and other relatively small water catchments, and breeding from these small domestic foci can create significant annoyance until they are discovered and corrected. The major problem areas are, however, extensive chronic breeding areas such as naturally existing ground pools, swamps, and other lowlands located for the most part in suburban and rural areas, as well as artificially created conditions such as those associated with sugar plantation cane wash water used for irrigation or soil reclamation. According to Holway (1958), under the latter condition (breeding associated with cane water) the adult population densities produced are more characteristic of irrigation, floodwater or salt-marsh mosquitoes than that of the familiar house mosquito.

In general, concerted control action against *Culex quinquefasciatus* has been handicapped by lack of sufficient funds to carry out an adequate program. There is no enabling legislation in Hawaii for the formation of mosquito abatement districts. The extent of control that is possible on land under State jurisdiction is dependent upon the biennial state legislative appropriation to the Department of Health for mosquito control. Actual control operations are carried out by the staff

of the Bureau of Mosquito Control, Department of Health. The scope of operation of the Bureau is dictated by its limited legislative appropriation and is confined largely to surveys, inspections, education and temporary control measures such as larviciding and adulticiding. The Department of Health's program is complemented by the respective control programs of the military and private industries such as the various sugar plantations. Also interested community organizations in high infestation areas have raised funds voluntarily to pay for airplane spraying. The Department of Health assists these communities by providing technical guidance as may be necessary to effect the aerial spraying.

In spite of inadequate appropriations, significant advances towards a more effective *Culex* control program have been realized through establishment of closer liaison and coordination of efforts by the various interested organizations. An example of this mutual pooling of resources is the joint mosquito light trap survey program initiated six months ago. Under this program, each participating agency operates several light traps within its own jurisdictional area and exchanges the trap data on a once-a-week basis. For example, the U. S. Navy is operating 14 traps in the Pearl Harbor and the Barbers Point areas. The U. S. Air Force operates four traps in the Hickam Field area. The U. S. Public Health Service has two traps: one at the International Airport, Honolulu and the other at its office location in downtown Honolulu. The Department of Health is currently operating seven traps in the various areas under State's jurisdiction. The U. S. Army is now in the process of obtaining a supply of light traps for establishment in Schofield Barracks and other areas under Army jurisdiction. The data from these weekly reports are compiled into a monthly summary by the Bureau of Mosquito Control, Department of Health for dissemination to each participating agency. This joint project provides valuable "intelligence" for each agency to use in scheduling control operations such as area fogging.

Control measures applied for *Culex* control in Hawaii include chemical control, biological control and source control.

Examples of chemical control are larviciding, and adulticiding (misting and fogging). The insecticide in general use today is malathion. It has replaced DDT because of the resistance problem. Based on limited testing to date conducted independently by both the staff of the Bureau of Mosquito Control utilizing the WHO test kit and Navy personnel of Preventive Medicine Unit #6, *Culex quinquefasciatus* larvae from different areas have shown resistance levels ranging from 0.0438 ppm to 0.250 ppm. For the most part larviciding is accomplished with ground operated hydraulic power sprayers. Occasionally, airplane spraying is utilized in high infestation areas inaccessible to ground equipment. This is financed through contributions raised voluntarily by community organizations. Misting is also practiced as an emergency measure in areas of high adult prevalence. Misting is done during the daytime to kill the adults as they rest on the vegetation. Area fogging by the Army and Navy is geared to prevailing light trap indices. The Department of Health attempts to keep up with the numerous requests for fogging from districts in high *Culex* prevalence areas by trying to accommodate them on a once-a-month basis, depending upon favorable weather conditions.

Biological control is practiced whenever possible by the use of surface feeding minnows to keep mosquito breeding under control in ground pools and other semi-permanent or permanent bodies of water. An outstanding case of effective control obtained with fishes is the result obtained in the ground pool located in the crater of famous Diamond Head. In March 1958, a record 17-inch rainfall in 48 hours enlarged the existing residual ground pool of about five acres into a miniature lake of about 35–40 acres. During normal rainfall years of the past, this rain-fed intermittent pool appeared during the rainier

months of the year but dried up after the summer months. Annually, during the period of its existence, control of mosquitoes was hindered by a dense canopy of algae growth (*Oedogonium*) on the surface of the water which protected the wrigglers breeding beneath it from being contacted with chemical sprays or by minnows. In anticipation of the algae problem, about 1,500 algae-feeding fish of the species *Tilapia mossambica* (originally introduced in 1951 from Malaya by the Fish and Game Division, Board of Agriculture and Forestry), were stocked in the pool immediately following the storm in March in an attempt to control the algae growth. At the same time about 30 bucket loads of *Gambusia affinis,* which thrives in almost any fresh water pond or stream in Honolulu, were also transplanted into the crater. For about the first three months mosquito breeding was evident under protection of the rapidly forming algae growth on the surface of the pond. In July, as anticipated, the prolific *Tilapia* multiplied sufficiently so that their feeding cleared the surface growth of algae and enabled the *Gambusia* to attack the wrigglers; consequently, no further applied control has been necessary for the past ten months.

Less spectacular and significant has been the degree of control realized to date with the various species of predatory mosquitoes of the genus *Toxorhynchites* (= *Megarhinus)* introduced into Hawaii in the past for the control of *Aedes albopictus* (Bonnet and Hu, 1955). Based on periodic observations over the past few years in former release areas by staff members from the Bureau of Mosquito Control, it appears that two species have established themselves in the wetter regions on at least two islands: *T. brevipalpis* and *T. splendens* on Oahu (Waimao Valley, Palolo, Haiku, Wahiawa and Makiki) and *T. splendens* on Kauai (Lihue). Although no comprehensive evaluation of the value of *Toxorhynchites* as a biological control agent in Hawaii has been attempted to date, superficial but repeated field observations have thus far pointed to poor control, based on the consistent findings that in spite of the presence of *Toxorhynchites* larvae in recovery areas, the adult *albopictus* population was literally "as thick as flies."

In Hawaii, as elsewhere, source control through land or water management is recognized as the fundamental approach to mosquito control. Economic reasons, however, have been a prime deterrent to the realization of voluntary source control specifically for the purpose of eliminating mosquito breeding such as in naturally existing swamplands. On the other hand, involuntary source control has been progressing to an encouraging extent at the expense of real estate developments inasmuch as the scarcity of real estate in Hawaii is forcing developers to reclaim swamplands for housing areas. Also, there has been talk of the possible use of a suitable abrasive agent to replace wash water for cleaning the sugar cane stalks before grinding. It appears highly in the realm of possibility, therefore, that in the not too distant future involuntary source control through real estate developments and improvements in sugar processing methods may contribute significantly toward the abatement of the current problem species, *Culex quinquefasciatus* in Hawaii.

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MOSQUITO CONTROL PROBLEMS OF THE IRRIGATOR

STERLING DAVIS [1]

In irrigated areas, it is waste water, or lost water, i.e., water not used by the plants, that is available for mosquito producing sites.

If we are to control mosquito production, we must acquaint the irrigator with irrigation practices that limit mosquito breeding: We can tell him that if he applies water using "good water management practices" and if he makes "better use of his irrigation water," no mosquitoes will be produced and crop production will increase. This over-simplifies the problem. We have told him what to do, but not how to do it. The irrigator still has many problems, including some which are very real and difficult to him, and others which he faces without even knowing they exist.

Each year some irrigators are faced with the task of filling an empty or partially filled container, having an unknown capacity, with a fluid flow of unknown size and with no way of knowing how fast the flow is going into the container or when the container is overflowing.

This process will be repeated again after some of the fluid has been removed at an unknown rate. These irrigators are using a stream of water that has not been measured which is applied to a field to fill the root zone of the crop with water. The irrigator probably does not know the potential water-holding capacity of the soil or the amount of water that is in the root zone when irrigation starts. Also, he probably does not know how fast the soil will take the water or when it will hold no more. After irrigating, he may not know how fast the plants take the water out of the soil.

The properties with which the irrigator is directly concerned are:

1. Root zone of the crop (i.e., that part of the soil from which the plant roots draw food and water).
2. Water-holding capacity of the soil (i.e., amount of water the soil will hold against gravity).
3. Soil moisture before irrigating (i.e., amount of water already in the soil).
4. Intake rate (i.e., the rate at which the soil takes water).
5. Deep percolation (i.e., water that goes through the root zone of the crop and is lost).
6. Consumptive use (i.e., actual amount of water used by the plants and evaporated from the soil surface).

These items present a problem for the irrigator because soil-water-plant relationships need to be understood for each soil type.

To add to the problems of the irrigator, we tell him he must have his land leveled properly and/or the irrigation system designed and installed for the type of soil that exists. He is also told that he should have good water control structures and operate his system as designed.

This may all seem fairly hopeless to the irrigator, or to us to try to encourage the irrigator to perform as we would like him to. However, in most areas there is some information and help available for the individual who is interested or who can be persuaded to use it.

The first major problem on which help will be needed may be land leveling. Many times both engineering and financial assistance are available to help level land that requires reshaping.

Another problem on which help is available is the design and operation of the irrigation system. Irrigation guides are available in many areas, as well as assistance in use of the guides, from various state and federal agencies. Information available in these guides for each soil type

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in an area includes: suggested irrigation system, frequency of irrigation, stream size, length of border or furrow, spacing of furrows or width of border, sprinkler application rates, amount of water to apply, crops to plant and other physical data needed in irrigation design and operation. When this information is available, the irrigator need not worry so much about other soil factors unknown to him. Knowledge of these other factors was used by experienced technicians in developing the suggested designs in the irrigation guides. Information in these guides will, if used as suggested, be an important factor in mosquito control.

In certain areas problems may develop that are not covered in the general guide, many of which will require research work. For example, in the Milk River Valley of Montana large acreage of high-percent clay soil exists that was producing only small amounts of poor quality native hay. The per-acre return on this soil was so low that good water management practices were not economically possible. Water was applied in large lakes for weeks at a time, resulting in prolific mosquito production. In addition to the low cost of applying water as lakes, the impression was prevalent that the water went into the soil very slowly and must be ponded on the area a long time. However, research results have shown that most of the water that goes into this soil goes in during the first few minutes after application and no water goes in after twenty-four hours.

Research has also shown that by intermittent applications of water and with fertilization, production of the native grass can be increased about ten-fold. In addition, with good water management and application of nitrogen fertilizer, many other grasses will produce yields of more than five tons per acre. Alfalfa, also, will yield over five tons per acre with intermittent water applications. Corn and sugar beets will also yield well with the same combination of the right amount of water and fertilization.

The problem of getting the irrigator to apply the water as recommended still exists, but further education on use of present information and research to develop better irrigation methods should someday make a large contribution toward reducing mosquito populations by source reduction methods.

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MOSQUITO RESEARCH FROM AN OPERATOR'S VIEWPOINT

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WHAT DO WE MEAN BY RESEARCH

Webster defines research as an investigation, inquiry, inquisition, inquest or probe; a search for truth, knowledge or information. For our immediate interpretation here, research might be limited to inquiries and investigations carried on by scientists and others especially for the sake of uncovering new knowledge, of getting at the facts when these are not known, or of discovering laws of nature.

How does this definition apply to the field of mosquito control operations?

It is hardly necessary to point out that to do without continual investigations, or a search for better ways of accomplishing control, is to accept existing operations as being adequate or the ultimate; in other words, to suggest that improvement of effectiveness or efficiency is not probable or practical. Such an attitude would be like the proverbial ostrich burying its head in the sand. I am sure we are all agreed that few control operations, if any, should be content to rest with existing knowledge and control techniques. On the contrary, we find that most operational agencies are continually seeking new answers, and through them, the development of better methods of attack, and better insecticides and equipment.

Mosquito control agencies are established and maintained for the purpose of suppressing mosquito populations and even eradicating certain species. However, if such agencies were content to carry on with only the well established tried and true operations, they would rapidly fall behind the times and become inadequate in fulfilling their functions. Where would we be today without the acceptance and use of DDT, other chlorinated hydrocarbons and the phosphate insecticides; without the formulations and control techniques with residual treatments, larvicides, granules, mists and aerosols; without airplanes and all the other specialized equipment designed to use these insecticides in markedly different manners under widely varying conditions. If operations are to progress and improve, mosquito control agencies must continuously carry on investigations along with their daily operations. While doing this we cannot, however, lose sight of the fact that mosquito control agencies' primary concern and effort must be concentrated on their control activities. The extent to which these agencies can devote time and energies and carry the expense of such investigations will vary widely. Their search for answers will usually be in the classification of field trials. They are rarely staffed with the professional personnel or have the necessary equipment adequately to carry on the technical phases of research, to come up with the basic knowledge and answers needed today. Obtaining basic answers would therefore have the most likely prospect of success when handled on a full time basis by trained specialists in such fields as chemistry, biology, limnology, physiology, engineering, etc. Control agencies need and solicit the aid of universities and other research centers adequately staffed and equipped to develop the basic knowledge necessary to improve and guide their operations.

To facilitate the advancement of research for mosquito control purposes, it is necessary that operations investigations be undertaken and carried on to the greatest extent possible by control agencies; that they solicit and obtain the help of universities and other research centers in seeking the multiplicity of data required in answering their problems. The interest and efforts of both groups need to be coordinated as closely as possible, with problems

coming from the field to the research center, and promising laboratory knowledge and developments returned to the field for final evaluation with the aid of control agencies.

Up to this point, I have attempted to outline a general pattern of a mosquito control agency's views concerning the need for and an approach to research. Here it might be timely and might stimulate discussion to enumerate a few specific problems that are of interest to mosquito workers today.

1. The phenomenon of insects developing tolerance to insecticides:
   A. How does tolerance or resistance develop?
   B. What rates of development can be expected?
   C. What can be done to prevent it?
   D. What can be done to overcome it?

I am sure we were all pleased to learn that the WHO is beginning studies, hoping to determine the basic facts in this problem.

2. The development of new insecticides for use in mosquito control.
3. Research on the performance and efficiency of insecticidal formulations for mosquito control purposes.
4. Toxic hazards involved when using different insecticides in various formulations.
5. Research on the biology and physiology of mosquitoes.
6. More comprehensive evaluation of biological control techniques and improved methods of evaluation.
7. Improved source reduction measures.

CONVERSION OF TODD INSECTICIDE FOG APPLICATOR FROM GASOLINE TO PROPANE AS FUEL

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The problems facing any mosquito control district attempting a program of adult mosquito abatement by chemical methods are many and varied.

Wind velocity and direction are problems. Temperature, humidity and things such as adequate access roads for ground equipment all tend to confuse the issue. However, these are things over which we have no control. One problem that has always faced our District is the failure of mechanical equipment to function properly when it is needed.

Surely, many a director of a mosquito control program has added grey hairs when, after promising numerous residents of an infested area that their area would be worked that night, he learns that the machine used for the work operated some 30 or 40 minutes, then suddenly required two or three hours of field maintenance—and this just at the time when the work should have been in full swing.

Every mosquito control district which attempts an adulticiding program must encounter a problem of this nature, regardless of the type of equipment used.

The Lee County (Florida) Mosquito Control District operates nine Todd Insecticidal Fog Applicators (TIFAS) in a program designed to provide adult mosquito abatement throughout the major populated areas of the district.

These machines function admirably when they are kept in operation constantly —say 3 to 5 nights a week. But when they are reactivated after a period of inactivity, the trouble begins. Operating smoothly during stationary trials in the yard, the machines emit great clouds of fog. Move them, and what happens?

The gas jet in the combustion chamber becomes clogged. Well, you say, it takes only 10 minutes or so to clean it. But suppose the loss of heat is caused by a pump that refuses to prime itself; or, when primed, refuses to pump not more than 10 or 15 pounds of pressure; or, even worse, refuses to produce any pressure.

Or, suppose the gasoline pressure regulator valve stops up or sticks, extinguishing the fire in the combustion chamber, or worse, the fire still burns, but the Briggs stops, out of gas. Sometimes the float in the Briggs carburetor sticks and gasoline dribbles out over everything.

Another problem in connection with gasoline leaks is the gasoline running near the hot distributor head from a leaky tank, necessitating a change of gasoline tank. One does not always have the time to change tanks.

If you have had some of these problems with your equipment, you are not alone. We in Lee County have had them all, and others, many, many times.

At this time, however, we have found one of the answers to a number of problems inherent in the equipment we operate, the TIFA.

Although we have modified this machine several times, the best of these changes has been to convert the machine to propane operation. It is impossible for me to give sufficient emphasis to that statement. It sounds simple and it is. But the rewards are many.

We entered this field blindly, without any knowledge of what we would accomplish, with a goal no higher than that of cutting fuel costs. In our State of Florida the mosquito control districts are subject to 7¢ a gallon state tax on gasoline. This is true in every case, since the State gasoline tax is specifically on the manufacturer and not on the consumer. At this time propane gases are not subject to this tax. Although a tax on LP gas used as fuel in motor vehicles is applied and reported to the State quarterly on a miles traveled basis, fuel used in stationary engines such as the TIFA is not taxed at all.

Our original intention was, thus, to save 7¢ a gallon State tax. Actually, we have not entirely accomplished that purpose. Our price for regular grade gasoline this year is 12.31¢ a gallon, plus 7¢ State tax, or a total of 19.31¢ a gallon. At this time, our cost for LP fuel is 16¢ a gallon without any tax. Therefore, we save 3.31¢ a gallon instead of the intended 7¢, but this amount represents a substantial saving in fuel costs when operating nine machines.

So we accomplished our original aim—to cut fuel costs.

But, in the course of our work (some eight months having passed since the machine was first successfully operated on propane in the field), we have found that the benefits derived from this conversion were far greater than we had ever anticipated. When the conversion was complete something else had evolved. The machine worked, and it worked well when we wanted it to work. There were no strainers to stop up, no gas pump to fail, no gas pressure regulator valve to give trouble and no carburetor float to stick.

Every major problem inherent in the gasoline system of the TIFA had been eliminated.

The District has now converted six of these machines to LP gas operation at a cost of approximately $100 a machine, not including the cost of the fuel storage tank. We expect to complete the same modification of the remainder of our units within the next 30 days.

Our experience with this propane operated machine has left us enthusiastic. We believe it to be the most reliable machine available for adult mosquito control. The truck operators find it a real pleasure to operate this equipment after their experiences in previous years; and, I can assure you, the director is the man who really benefits. That peace of mind at the dinner table, knowing that the units assigned to fog several hours each that night will accomplish what they set out to do, makes this modification well worthwhile.

THE 1958 *AEDES AEGYPTI* DISTRIBUTION IN THE UNITED STATES

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Yellow fever is one of the most severe diseases affecting mankind. In the past, great epidemics of this disease have exacted large tolls. For example, in 1878 New Orleans had 13,817 cases with 3,984 deaths out of a population of 216,000 (Boyce, 1906). While the occurrence of yellow fever has been greatly reduced or eliminated from large areas of the world, the virus is still active in the tropical forests of South America and Africa, and the urban vector, the *Aedes aegypti* mosquito, is widely distributed. Because of the continual danger, the World Health Organization classified yellow fever as one of the six quarantinable diseases. By international agreement, when the occurrence of one of these diseases is suspected, it must be reported. Upon confirmation, quarantine measures are applied (World Health Organization, 1957). These measures were imposed in the case of yellow fever which was found in Biche, Trinidad, in January 1959.

Recently there has been a renewed awareness of the threat of yellow fever to the United States (Hayes and Tinker, 1958). In the past few years, an epizootic of jungle fever has moved from an enzootic focus in Panama through Central America to the Mexico-Guatemala border, posing a threat of overland introduction of yellow fever into the United States. The greater threat, however, is that of introducing the virus by means of infected mosquitoes, persons, or animals brought in by surface shipping or air travel. Thus, in those continental and overseas areas of the United States where *Ae. aegypti* continues to exist, there is a continuous possibility of a recurrence of epidemic urban yellow fever.

Three steps have been taken in the United States to prepare defenses against this threat. First, international quarantine measures have been intensified to reduce the chances of entrance of the virus (Hughes and Porter, 1958). Second, surveys have been conducted to determine the extent of the susceptible area (Bradley and Atchley, 1953; Hayes and Tinker, 1958). Third, a pilot eradication project was initiated in November 1957, in Pensacola, Florida, to determine the methodology and cost of conducting *Ae. aegypti* eradication.

Surveys to determine the distribution and density of *Ae. aegypti* have been conducted periodically since 1943 by the Communicable Disease Center and its predecessor, the Malaria Control in War Areas program. During World War II, surveys were made in connection with *Ae. aegypti* control projects in Gulf and South Atlantic port communities. In order to maintain current information on the species, Communicable Disease Center personnel conducted surveys of 31 communities in 1952 and of 25 in 1956. In July 1957, funds for conducting yellow fever investigations were made available to CDC by the Division of Foreign Quarantine. With these funds the surveillance program was continued with surveys in 38 communities in 1957, and the *Ae. aegypti* eradication pilot project was initiated. By the 1958 season, the areas of the United States in which *Ae. aegypti* could be found had been generally established (Hayes and Tinker, 1958). However, data were lacking for a number of areas, for example, the northern boundary in South Carolina and the western boundary in Texas. These data were supplied by the more comprehensive surveys in 1958.

Surveys for *Ae. aegypti* were of two types prior to 1958. The first involved only the recording of premises found breeding the mosquito during control pro-

TABLE 1.—Locations, types, and results of *Aedes aegypti* surveys conducted in 1958 by the communicable disease center

States (by east-west tiers)	Type of Survey			Number of premises surveyed	Results *
	Qualitative urban	Quantitative urban	Exploratory rural		
Florida	Ft. Lauderdale			23	+
	Ft. Myers			45	—
	Gainesville			118	—
	Ocala			13	+
	St. Augustine			12	+
	Tallahassee			42	+
		Panama City		216	0.0%
		Sarasota		225	0.0%
		Vero Beach		294	0.0%
			Escambia Co.	29	+
			Polk Co.	68	—
South Carolina	Beaufort			75	—
	Florence			18	+
	Greenville			2	+
	Spartanburg			29	+
	Sumter			101	—
		Columbia		272	22.8%
			Georgetown Co.	90	+
Georgia	Brunswick			21	+
	Columbus			38	+
	Macon			38	+
	Savannah			56	—
	Thomasville			11	+
	Tifton			112	—
	Waycross			15	+
		Atlanta		518	11.6%
		Gainesville		225	0.0%
			Thomas Co.	53	—
			Dodge Co.	155	—
Alabama	Dothan			2	+
	Huntsville			25	—
	Montgomery			4	+
	Selma			2	+
	Tuscaloosa			4	+
		Birmingham		429	14.4%
			Covington Co.	60	+
Mississippi	Clarksdale			17	—
	Columbus			50	—
	Greenville			43	—
	Meridian			9	+
	Natchez			62	—
	Pascagoula			45	—
	Tupelo			24	—
		Vicksburg		313	0.0%
			Montgomery Co.	155	—
Louisiana	Alexandria			9	+
	Lafayette			10	—
	Lake Charles			25	—
		Shreveport		340	0.0%
			St. James Parish	97	—

* Percent of premises found breeding given only for quantitative urban surveys.

TABLE 1—*Continued*

States (by east-west tiers)	Type of Survey			Number of premises surveyed	Results *
	Qualitative urban	Quantitative urban	Exploratory rural		
Texas	Abilene			63	—
	Ft. Worth			23	—
	Huntsville			11	—
	Kerrville			11	+
	Lubbock			21	—
	Midland			19	—
	Paris			6	+
	San Angelo			36	—
	Uvalde			22	—
	Victoria			23	—
	Waco			1	+
	Wichita Falls			33	—
		Austin		231	1.3%
		Tyler		210	18.1%
			Trinity Co.	117	—
New Mexico		Carlsbad		249	0.0%
Arizona		Tucson		269	0.0%
North Carolina	Charlotte			98	—
	Fayetteville			83	—
	Greensboro			92	—
	New Bern			60	—
	Rocky Mount			69	—
	Salisbury			80	—
	Wilmington			86	—
		Asheville		319	0.0%
		Raleigh		388	0.0%
Tennessee	Dyersburg			73	—
	Memphis			46	—
	Murfreesboro			43	—
	Pulaski			23	—
	Waverly			19	—
		Chattanooga		336	0.3%
		Jackson		190	0.0%
Arkansas	Arkadelphia			11	—
	El Dorado			3	+
	Ft. Smith			12	—
	Hot Springs			7	+
	Jonesboro			25	—
	Texarkana			23	—
		Little Rock		297	0.0%
Virginia	Danville			95	—
	Franklin			107	—
		Portsmouth		423	0.0%
Missouri	Cape Girardeau			21	—

* Percent of premises found breeding given only for quantitative urban surveys.

cedures. The sample size was usually large because all premises were inspected as part of the control program. The second type of survey had no connection with control work. Instead, premises on which *Ae. aegypti* breeding was considered possible were inspected in surveys lasting one week or less in a community. The sample size was relatively small, and the ability of the surveyor to select likely premises was important in determining results.

In 1958, three types of surveys were used to develop three sets of facts: quantitative urban surveys of 19 cities in which blocks inspected were selected by random sampling techniques to obtain a statistically valid determination of the magnitude of the species population; qualitative urban surveys of 65 cities where the presence of the species was determined in as short a time as possible; and exploratory rural surveys of 9 counties in which likely premises were inspected to discover breeding of the species in such areas.

The population statistics for *Ae. aegypti* from surveys made prior to 1958 are not strictly comparable since no standard method was employed for determining which blocks within the communities were to be sampled. Considerable bias in determining the population size was possible since each inspector selected his own blocks to be sampled. This bias was reduced in the 1958 quantitative urban surveys by selecting stratified random samples previous to the survey in each community. The samples were divided as follows: business premises, 10 percent; substandard residential premises, 60 percent; and standard residential premises, 30 percent. The rate of infestation by *Ae. aegypti* was expressed as the percentage of the inspected premises found breeding the mosquito.

Only the presence or absence of the species in the locality was determined with certainty in surveys made prior to 1958. In examining data from previous surveys, it was found that an extensive survey was not necessary to obtain only these qualitative data. A one- to two-day check of the most favorable habitats in the community was usually sufficient. In 1957, *Ae. aegypti* was found on the first day of the survey in 17 of 18 cities where the species was found, and on the second day in the eighteenth city. In fact, if the species was common, it was usually found in the first few favorable habitats inspected; this was the case in 11 of the 18 positive 1957 surveys, 4 of the 6 positive 1958 quantitative urban surveys, and 14 of the 23 positive 1958 qualitative urban surveys. By spending only enough time in a community to determine the presence of *Ae. aegypti,* a surveyor could visit many more cities.

There was little information on the rural occurrence of the species prior to the 1958 season, since only one of the previous *Ae. aegypti* surveys had been in a rural area. This information will be required in planning control and eradication programs. If *Ae. aegypti* were as common in rural as in urban areas, a much more extensive eradication program would be required. For this reason, exploratory rural surveys were made in counties where occurrence of the species was considered possible.

The 1958 surveys disclosed a large number of negative findings, especially in areas previously believed to be infested (Hayes and Tinker, 1958) (Table 1 and Figure 1). Lake Charles, Louisiana, and Memphis, Tennessee, were negative in 1958, although *Ae. aegypti* had been found in both cities in 1956. The absence of *Ae. aegypti* from Memphis was verified later in 1958 by the Tennessee Department of Public Health. Of the 42 cities where seaport and airport facilities were inspected by the Division of Foreign Quarantine, *Ae. aegypti* was found in only one, Savannah, Georgia, where they were not found during CDC surveys. Since 3 subsequent surveys of the Savannah port facilities by the Division of Foreign Quarantine and a survey of the whole city by CDC have failed to disclose further infestations, this positive finding was probably a temporary import. In the 9 rural surveys, only Escambia County, Florida, and Covington County, Alabama, had large *Ae. aegypti* populations. Only one of the premises was found breeding the

species in the other positive rural surveys; those of Georgetown County, South Carolina, and Thomas County, Georgia. No *Ae. aegypti* was found in St. James Parish, Louisiana, where in 1945 the last epidemic of dengue fever in the United States occurred.

The distribution of *Ae. aegypti* as determined from the 1956–58 surveys is shown in Figure 2. The shaded portion represents areas from which *Ae. aegypti* has been reported at least once since 1900, and was determined from a compilation of all published and unpublished reports obtainable. The limits were obtained by connecting the locations of the geographically extreme records. It is noteworthy that most of the extreme records were made in the period 1944–46. The distribution outlined in the present report differs somewhat from previous ones (Bradley and Atchley, 1953; Hayes and Tinker, 1958) by indicating the absence of records for the Appalachian area and west Texas. Records were found for only eight locations west of a line drawn from Wichita, Kansas, to Del Rio, Texas. Records of collections made east of the line are quite numerous. In Texas, the species has been found in 48 counties to the east and in only 2 counties to the west of the line.

The heavy shading (Figure 2) indicates that area where *Ae. aegypti* was found during the 1956–58 surveys and can be described as that in which the species is usually common. The lightly shaded area is that in which *Ae. aegypti* has been found occasionally. The map shows strikingly that the area where *Ae. aegypti* is common at present is much smaller than that where it had been found in the past. The extent of the area from which it has been reported is approximately 662,000 square miles, while the present distribution includes approximately 202,000 square miles, only one-third as much area. Because the limits of the area recognized as "yellow fever receptive" follow state lines, this area is larger than that from which the species has been reported (Hughes and Porter).

FIGURE 1

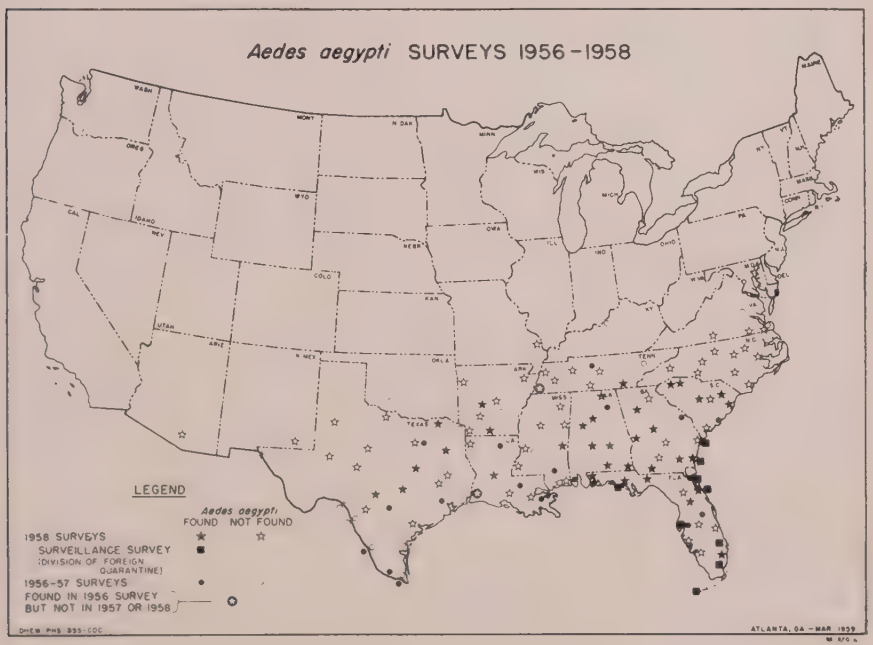
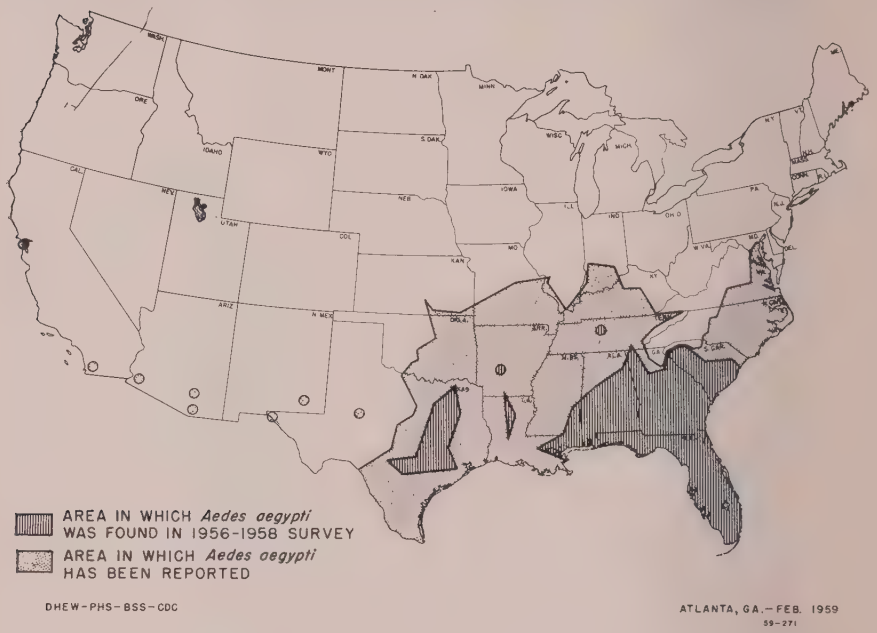


FIGURE 2

DISTRIBUTION OF *Aedes aegypti* IN THE UNITED STATES


AREA IN WHICH *Aedes aegypti* WAS FOUND IN 1956-1958 SURVEY
AREA IN WHICH *Aedes aegypti* HAS BEEN REPORTED
DHEW-PHS-BSS-CDC
ATLANTA, GA.—FEB. 1959
59-271

Even though the trend toward reduction in the area infested by *Ae. aegypti* is apparently continuing, the infestation is still extensive, and there are communities where *Ae. aegypti* populations are large. If the yellow fever virus should be introduced in cities like Tyler, Texas; Birmingham, Alabama; Atlanta, Georgia; or Columbia, South Carolina, an urban outbreak of yellow fever would be a distinct danger.

On the other hand, the data from this study indicate that consideration can be given to revising the area of the United States presently recognized as yellow fever receptive. This area was delineated by the Public Health Service and reported to the World Health Organization in 1953 in accord with article 70 of the International Sanitary Regulations (World Health Organization, 1957). Hughes and Porter (1958) point out that the delineated area will be modified as necessary to reflect changes in the distribution pattern of *Ae. aegypti*. The area presently recognized as receptive for yellow fever is five times that in which infestations of the species were found during the recent surveys. Should this condition continue for another year or two, the Division of Foreign Quarantine will undoubtedly act to revise its delineation of the yellow fever receptive area.

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INCREASED EFFICIENCY THROUGH USE OF BARGE TO FLOAT DRAGLINE OR CLAM SHELL CRANE

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I will endeavor to be entirely objective in my appraisal of the comparative operations between machines operating on Mats and those operating on Barges.

Initial Design Problem Involved. Several basic factors had to be considered in designing the first barge to float a unit one-half yard dragline: First, we considered the width and length of the unit machine to be mounted; second, consideration was given to the gross weight of the machine plus the weight of the loaded bucket which would extend twenty feet beyond the end of the barge; third, it was necessary in our planning that the barge after loading would be maneuverable and have sufficient floatation to be readily movable in both deep or shallow water.

Type of Barge Desired. The type of barge desired was one to be built of steel with three water-tight compartments; a rear tank for ballast large enough to hold water sufficient in weight to equal the weight of the unit; a center tank for fuel; and a small storage compartment at the forward end. I desired a spud and spud well on each side of the working end of the barge for stability; plus a hand winch with cable and anchor mounted on after end of the barge on each side to hold the barge stable and permit it to move forward and backward.

This information was placed in the hands of the Engineering Department of the Olson Boat Works for study.

Results of Engineering Study. The aforementioned Engineering Staff, after research and study, approved a design for a barge 15 feet wide, 3½ feet deep, and 35 feet long. The displacement of water by the barge would support 65,000 pounds plus its own weight of 28,000 pounds. This would be ample to ballast the afterhold with 30,000 pounds of water. The fuel tank would be constructed to hold 1,000 gallons of fuel. The depth of the draft would give the barge the necessary stability in rough water.

Procurement of the Barge. Satisfied that the engineering study had given us what we wanted, invitations to bid, which included detailed plans and specifications, were sent out. These detailed plans and specifications are available if desired.

The Olson Boat Works, bidding $6,000.00, was the low bidder. Six weeks were allotted for the building of the barge.

Upon completion, since the barge was too large for highway travel, it was towed up the St. John's River to Jacksonville from DeLand and then down the Inland Waterway to Daytona Beach, a distance of 247 miles in two and one-half days' running time. Transportation cost was reasonable.

Putting the Barge Into Operation. The barge was put into operation immediately. Through its use, we moved two of our draglines onto islands south of New Smyrna Beach. These islands were inaccessible other than by barge. Deep water was not available at the shore lines of these islands so we dug our way in with the draglines operating off the barge.

We continued using the barge in this operation . . . moving the draglines from island to island until the work was completed. The draglines were then returned by barge to the mainland.

Breeding areas totaling 400 acres on these islands were eliminated through this operation. Without the barge it would have been impossible to perform this permanent control work.

Ditching from the Barge. Actual work in ditching from the barge began in January 1957 when a new dragline equipped with an Erie ½ yard Clam Shell bucket was purchased.

The first few days of operation were slow. Some changes in the final position of the dragline on the barge had to be made. The difficulties experienced were eliminated by use of 5/8 x 4 steel bars made in two parts. These were welded to the sides of the barge, the bars extending across the frame of the dragline from side to side, both front and back. Thus the movements of the barge and the dragline were as one solid piece of equipment with no slipping or moving on the deck.

This rigidity having been accomplished, the operator soon picked up the rhythm of, you might say, "Rock and Roll" in the operation. By the end of the month, he had tripled the lineal feet of ditch dug by a like machine operating on mats in the same area for the same period of time. Ditches were uniform, being 15 feet wide —5½ feet deep—with flat bottom and straight up and down sides to the canal being dug.

During the early stages of operation, it was found that the spuds and anchors were unnecessary. The barge moved forward automatically as the ditch was dug.

STATISTICAL ACCOMPLISHMENTS. The operator, operating from the barge in heavy marsh mud, operates at the rate of six buckets per minute. His average day's work is 550 lineal feet of 15 x 5½ canal or 1,530 cubic yards . . . at a cost of two-and-eight-tenths cents per cubic yard.

The daily record of the three draglines in operation during 1957 . . . two on mats, one on the barge . . . produced these totals: For the year—

A total of 167,610 lineal feet were dug, 391,726 cubic yards were moved and 662 acres of land were improved.

The floating dragine accomplished (of the above total) 74,633 lineal feet dug—203,872 cubic yards moved. This averages 65 percent more work accomplished by the floating dragline than accomplished by either of the draglines on mats. The floating dragline moved more spoil than that moved by the other two draglines together . . . an outstanding record.

COMPARATIVE ANNUAL COSTS. The combined annual cost of operation of the floating dragline (including salaries, fuel, oil, gas, cable and depreciation) totals $8,687.00, or slightly over four cents a yard of spoil moved.

Comparable cost of draglines on mats total $17,720.00, at a cost of slightly more than nine cents per yard of spoil moved.

So far as lineal feet dug is concerned, the floating dragline accomplished this job at approximately eleven and six-tenths cents per foot while the draglines on mats accomplished the same job at slightly over nineteen cents a foot.

OTHER BENEFITS OF FLOATING OPERATION. In addition to lower cost of operation, other advantages are that there is no wear on the crawlers, chains, rails spreads and pins and bushings. A floating unit is always high and dry with no chance of slipping off mats or getting stuck crossing small streams, both of which are ever present hazards.

NEW BARGES RECENTLY PURCHASED. The two new barges purchased this year are a two-pontoon barge with overall measurement of 15 x 32 x 3½ feet. It was constructed in two parts so that it could be transferred by tractor and low-boy from one project to another. Several of our projects have no navigable waterway entrances. Each pontoon, weighing 12,000 pounds, can be moved singly and launched separately and assembled while floating in a pond dug by the unit. As with the first barge, copies of detailed specifications are available. Operation of this barge has proved as satisfactory as that of the solid barge. This operation has proven so successful that the fourth and last machine is being mounted on a two-part barge in May of this year.

MOSQUITO CONTROL IN SLUDGE LAGOONS

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This paper describes the physical structure, history and present condition of the sludge lagoons operated by the Metropolitan Sanitary District of Greater Chicago. Although the sanitary district has an enviable record for operation and efficiency, these lagoons have defied efforts of both the sanitary district and mosquito abatement district to control mosquito breeding. This type of mosquito breeding area may be a problem peculiar only to our mosquito abatement district.

These thirty open air sludge lagoons are located between the Desplaines River and the Ship and Sanitary Canal, not far from the geographical center of our district and are used primarily for storage of activated sludge that cannot be treated by regular plant facilities, badly overloaded at the present time. Approximately 150 to 300 tons of sludge are pumped into these lagoons daily.

They consist of 230 acres of partly digested sludge, open water, and areas covered with various types of vegetation such as marsh grass and algae. The size varies from 100 by 200 feet to 300 by 600 feet, with an original depth of 20 feet. At the present, top of sludge is about four feet from top of beds with a few inches of water covering sludge. The banks have a 1 to 1 slope and are covered with dense growths of vegetation. These lagoons support prolific breeding of *Culex pipiens* from mid-June to late September. The hordes of mosquitoes produced here have caused serious annoyance to residents of communities within flight range, particularly to the north and east, because of prevailing southwesterly winds.

The first lagoons were constructed about twelve years ago and more have been added from time to time. Although no new ones are contemplated, the possibility of increasing the area still exists, and it is certain they will be with us for many years to come.

At the moment this is written, Chicago newspapers report that the sanitary district has authorized its engineers to draw up specifications for construction of three additional treatment plants to dispose of the sludge. When these will be in operation no one can say, but until that time and possibly even beyond, we will have the problem of mosquito control on any lagoons that continue to exist.

Cooperation between the two districts has resulted in a substantial improvement in mosquito control since the severe annoyance of 1955. The mosquito abatement district has provided routine inspection service and also technical assistance when desired, while the sanitary district has provided personnel and equipment and has done the actual spraying of lagoons.

Reasonably good control was attained during the first few years when the method was to flood as few beds as necessary, about 10 or 12, allowing a crust to form on the others, which would inhibit mosquito breeding.

Then, in 1955, the sanitary district evolved a new theory: to introduce fresh sludge into all thirty beds at once in the belief that this would stop breeding for as much as six weeks. This wholesale flooding prevented formation of a crust on any of these beds, and close inspection by our men revealed a new brood two to four days after flooding.

The ensuing flights of *Culex pipiens* resulted in widespread annoyance reminiscent of days before the organization of the Desplaines Valley District; people reported killing as many as 70 mosquitoes in one night in their bedrooms.

In this particular emergency we were compelled to help the sanitary district spray these lagoons at weekly intervals, although other parts of our control program had to be neglected. The sanitary district's equipment and personnel were inadequate to handle the emergency.

The sanitary district has, during the course of years, used anything available for larviciding, such as old, discarded crankcase oil, transformer oil, cutting oil, etc., and many different chemicals, such as DDT, chlordane, Lethane, dieldrin, etc. in varying mixtures and percentages.

This, together with untrained personnel, made it difficult to determine the proper or most effective treatment. For this reason it was agreed between the two districts that, in the future, regular, semi-weekly inspections would be made and technical assistance provided whenever requested by the sanitary district. The sanitary district agreed to spray within twenty-four hours after inspection any lagoons that were breeding. Each district pays the cost of labor, material and equipment for its part of the work.

This procedure has been followed since 1955 with a marked improvement in control of mosquito breeding. The cooperation between the two districts has been good and much has been accomplished.

Desplaines Valley District made an experiment with granular dieldrin on one lagoon in April 1958 with such encouraging results that the sanitary district decided to treat all lagoons with dieldrin emulsion. This application was made the first week in August when seventeen lagoons were breeding. Breeding was immediately reduced to only five lagoons, but by the following week had jumped to an all-time high of twenty-four. Fifteen were very high, twenty-five or more per dip, producing an estimated 10 million *Culex pipiens* per brood. The failure of the dieldrin may be attributed to the fact that our good experimental results were obtained in cool weather, while hot weather in August when all lagoons were treated may have destroyed effectiveness of this chemical. The change from granular to emulsion may also have been a contributing factor. The mosquito abatement district had similar experience in spraying of polluted ditches, etc.

To facilitate daily coverage of lagoons, we had agreed that anything less than 25 per dip would be considered acceptable, certainly not up to our standards elsewhere of only one per dip.

The sanitary district then decided without our knowledge to use a 25 percent mixture of DDT, chlordane and dieldrin at an unknown rate. Inspection by our general foreman and inspector a few hours after treatment indicated breeding of as much as 500 per dip in beds just sprayed with above mixture.

In a desperate attempt to regain control, the mosquito abatement district again had to enter the picture with additional equipment and personnel and made two applications of 8 percent DDT in fuel oil at rate of 1 lb. per acre. This treatment resulted in an immediate reduction of 70 percent in number of lagoons and 90 percent reduction in intensity of breeding that lasted until the end of the season on September 26.

Looking back at inspection and larviciding records for the past three years, no clearcut pattern of behavior of certain lagoons or certain calendar periods could be determined. However, missing of a single semi-weekly routine spraying was reflected by increase in breeding. An increase was nearly always present on Monday; apparently the days lost by weekends were an important factor. No apparent relation in breeding could be detected between absence or presence of vegetation or between different types of vegetation.

Our technical staff noted that in two instances, one in each of two different years, use of insecticide containing fuel oil appeared to obtain a better and longer lasting effect than the use of emulsions or granular preparations. This is somewhat confirmed by experiences and/or suspicions of mosquito control workers elsewhere. Possibly just as good results may be obtained by use of fuel oil alone as no residual effect can be expected. This conclusion has also been advanced by other mosquito control workers. These approaches will be explored more thoroughly in 1959.

As the vast part of mosquito larvae tend to be concentrated along the banks of these lagoons, often in heavy vegetation, it seems that our present method of application with mist blowers leaves much to be desired.

A long boom with numerous jets such as is used in agricultural spraying might be satisfactory. This boom could be extended from a truck on the bank over the lagoon's edges only three or four feet above the water's surface. This would tend to concentrate the larvicide where most needed and also prevent excessive loss by wind drift, as high winds are prevalent in this area.

The problem of control of these lagoons will be with us for many years to come. Any further control measures must also be undertaken with the realization that mosquito resistance to DDT or other chemicals could develop. In fact, some suggestion of such a condition has been noted during the past two years, although good control is still obtained when proper techniques of spraying are observed.

THE PROPOSED DAM ACROSS THE DELAWARE RIVER TO EXCLUDE TIDES, AND ITS POSSIBLE EFFECTS ON MOSQUITO CONTROL

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The purpose of this paper is to bring to your attention a proposal which would change existing conditions in a large tidal river basin. It is intended to indicate some of the very complex problems involved:—economic, engineering, legal, physical and health effects, including mosquito control arising from this proposal. There is no historical precedent for a proposal such as this, so we are on our own, so to speak, in speculating as to results.

The Delaware River carries the water run-off of about 7,000 square miles of eastern Pennsylvania, part of New York, western New Jersey and northern Delaware. From Trenton, New Jersey, southward past Philadelphia, it is tidal for 75 miles to Delaware Bay, flowing through a highly industrialized and heavily populated area. Although there is a normal rise and fall of tide of about six feet, the water is fresh down to about Wilmington, Delaware. The deep water channel averaging 40 feet in depth at Philadelphia, carries an enormous river traffic.

Because of the fresh water in the river, the water is used for industrial and residential purposes in large quantities. However, even larger quantities of fresh water will be needed in the future. The State of Delaware, looking ahead to water requirements for the next fifty years, has therefore asked that the comprehensive resources survey of the water of the Delaware River, now being carried on by the United States Engineers, consider the feasibility of a barrier dam in the Delaware estuary. A preliminary survey of this proposal has been approved and is now underway.

The proponent of the barrier, the State of Delaware, suggests a site in the New Castle-Pea Patch Island locality. The primary purpose of such a structure would be to prevent the intrusion of salt water into the area upstream of the barrier. The barrier would create a slack fresh water pool at the elevation of the present mean high tide extending from the structures to the head of tide at Trenton, New Jersey,

on the main stem of Delaware River and upstream on the tributary streams above the barrier to the head of tide on these streams. All communities above and below the barrier in the tidal section of Delaware River and its tributaries would be affected.

The proponents of the barrier anticipate vast benefits to industries requiring fresh water. They also envision the expansion of present industries and the development of new industries as a result of the fresh water supply.

Proponents also feel that the creation of a fixed shore line will greatly improve recreation facilities, and that the barrier dam will prevent damage by hurricane or extra high tides backing up from Delaware Bay and also from flood run-off from the headwaters upstream. The barrier dam would also result, by raising the water level six feet, in increasing the channel depth by this amount.

On the other hand, opponents point out that the enormous water borne commerce amounting to 101,000,000 tons yearly and requiring nearly 800 passages daily in and out of the River, would require very large locks, 1,200 feet long, 150 feet wide and 50 feet deep, through the dam. There would be large losses of time waiting to transit the locks, more chance of ship collisions, and in the event of war, a possible complete blockage of Navy vessels at the Philadelphia Navy Yard as well as commercial vessels.

Information will also have to be secured as to fish and wildlife effects, on oyster culture, an important industry in Delaware Bay, and the effect of the proposed dam on existing drainage systems, flood heights above and below the barrier, and on existing sewer and waste outfalls.

The legal problems arising in connection with the proposed dam across the Delaware are many and complex. To put the plan into operation may require legislation to change existing law or to define certain areas within the law with respect to the relative rights of individuals, municipalities, the four states, and the federal government. The constitutional questions of the police powers of the states and the federal government's powers with respect to the commerce clause, national defense and emergency, and public health and welfare all pose problems of considerable breadth and scope.

Now, as to mosquito control—At present the movement of tide water, fresh water most of the 75-mile stretch of the River, sweeps out mosquito breeding along the banks of the Delaware. The tidal rise and fall in tributary streams and side marshes also reduces mosquito breeding considerably.

What would be the effect of substituting a 75-mile-long lake in place of the present tidal river?

Would mosquito-eating fish tend to increase or decrease?

Would aquatic vegetation also increase, forming dense masses and prevent fish from penetrating side marsh areas?

Let us consider the effect on various species of mosquitoes—

1. Would *Anopheles quadrimaculatus* increase in permanent side pools?
2. With less fluctuating all year water elevations, would *Mansonia* species increase in breeding?
3. With the river water in varying degrees of pollution from slight to heavy, due to sanitary or industrial waste,—would breeding of *Culex pipiens* or *Culex salinarius* increase along the river edge to any considerable extent or in tributary creek swamps?
4. What would be the effect on breeding of *Aedes vexans* and similar floodwater varieties?

In a recent paper by W. E. Snow of the Tennessee Valley Authority: "Production and Control of Floodwater Mosquitoes Incidential to Water Level Operations on Reservoirs of the Tennessee Valley Authority," read at the Tenth International Congress of Entomology (Vol. 3—Proceedings), the Abstract reads, as follows:—

"As the marginal growth band has be-

come more stabilized along the main river reservoirs due to regularity of water level operations, the floodwater mosquito *Aedes vexans* has become well established in the zone just above top summer pool level in certain reservoir areas. This zone is surcharged in the spring to strand flotage, as a malaria control operation, and incidentally hatches an initial brood of floodwater mosquitoes. If the surcharge phase and recession to top pool level occur over a period of about 5 days, many larvae in grassy, well-drained situations become stranded in the vegetation. On the other hand, if water remains in the surcharge zone for several weeks, emergence of *A. vexans* generally occurs. The weekly cyclical fluctuation and seasonal recession phases of the malaria control program are especially favorable for the control of floodwater mosquitoes. Even when rains coincided with the upper end of the cycle and hatching in marginal grass occurred, scheduled recession over the next few days was sufficient to eliminate larvae by stranding. On many of the reservoirs in the tributary watershed, seasonal water level recession is a regular operation whereby stored water is gradually released during the drier periods in summer and fall for downstream use. A recession rate of 0.2 to 0.3 feet per week beginning shortly before July 1 has been found adequate for mosquito control. When stored water is allowed to remain in the marginal growth band for several weeks in the spring before recession is begun, small numbers of *A. vexans* usually emerge. In instances when the growth band has become periodically flooded during the summer with intermediate drawdown periods of several weeks intervening, very large populations of *A. vexans* have been produced."

The point is that the T.V.A. lakes have somewhat controlled draw down periods. In the case of the proposed Delaware River impoundment there would not be a controlled drawdown of water. Hence heavy rains in the upper Delaware Valley above the tidal pool might easily raise the water level in the pool for long enough periods with the possibility of liberating a large brood or broods of *Aedes vexans*.

This paper does not pretend to give the answers to the above problems. It is intended to show how mosquito control ties in when changes concerning water conditions are involved. It is hoped to have you contribute ideas of your own, as there is no precedent for the Delaware River proposal, as far as I know. In the future, however, there may be similar proposals elsewhere in the world that you may have to consider.

UTAH MOSQUITO ABATEMENT ASSOCIATION

Sixty per cent of the people in the state of Utah are now living within the boundaries of organized mosquito abatement districts.

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ARTICLES

NOTES ON THE BIOLOGY OF SOME SPECIES OF UTAH BLACKFLIES (DIPTERA: SIMULIIDAE)[1]

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Little is known of the habits and habitats of many of the western species of blackflies. From 1951 to 1958 observations were made on several species that occur in Utah and are presented below as a contribution to the knowledge of the western blackfly fauna.

Prosimulium exigens DYAR AND SHANNON. In Utah, the immature stages of *P. exigens* are found usually in streams of small to moderate size, although occasionally they occur in the larger streams. Most frequently the streams range from less than 1 foot to 5 feet in width, from about 4–24 inches in depth, and have current velocities from 0.82–4.3 feet per second. Most of the streams have an abundance of emergent aquatic vegetation or trailing grasses and branches from streamside vegetation, and many shaded areas. The stream beds are usually of mixed mud and gravel. Rarely are larvae and pupae found in any numbers in streams with very rocky bottoms or lacking in aquatic vegetation, although small rocks are preferred for attachment.

The species overwinters as larvae and emergence occurs in the spring; the adults, at elevations up to about 7,000 feet, have usually disappeared by early June. However, at elevations above 10,000 feet gravid females have been collected as late as September 11 (1956). The later emergence at higher altitudes is probably related to the lower temperature of the water, as was pointed out for the Alaskan species of blackflies by Sommerman *et al.* (1955). There is only one generation each year at any given locality and, in general, emergence is complete by the time the stream temperature reaches approximately 65° F.

The larvae are found usually in discrete groups of various sizes. Many such groups constitute a population that is itself sharply differentiated, one population often being separated from the next in the same stream by a mile or more. This was the case in Utah, in Red Butte Canyon and City Creek Canyon, where collections were made over an eight-year period. Often this made the search for the species difficult, but when found there was no scarcity of specimens. The factors that produce this type of local distribution remain unknown.

The larvae were found occasionally attached to the substrate by the anterior end, being held firmly in place by means of a small mass of silken material exuded from the labial or silk glands. The body of the larva floated downstream, but was held close to the substrate. When touched, they immediately attached themselves by the anal hooks in the usual manner and released their hold anteriorly to curl up on the substrate. This unusual position may be a resting attitude.

When the mature larvae are ready to pupate, they congregate to spin their sock-like cocoons. The pupae occur in rather large masses, often ½–1 inch thick, 8–10 inches in diameter, and often are covered by sediment. Many such masses may occur within a small area. Larvae have been observed to work their way under a layer of pupae in search of a suitable position in

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which to pupate. The pupa, just prior to emergence, pushes itself from its cocoon so that the entire cephalothorax is exposed and emergence of the adult is made easier. Often these pupal masses are so thick that adults emerging from the lower layers cannot work their way to the outside; many such trapped and dead individuals have been collected. The author has observed that it is easier to rear a small group of *Prosimulium* pupae than it is to rear individual pupae, and there may be some positive thigmotrophic response which, in some way, facilitates their development.

Newly emerged and older adults of both sexes have been found resting during the heat of the day in culvert pipes and under bridges where it was cool and moist.

The oviposition habits of *P. exigens* are discussed by the author in another paper (Peterson, 1959).

Prosimulium fulvum (Coquillett). Little is known about the biology of *P. fulvum* in Utah. On June 28, 1958, three miles northeast of Mirror Lake, Duchesne County, at an elevation of 10,050 feet, numerous mature larvae and several pupae of this species were found in a small stream on an alpine meadow. The stream varied from 4–12 inches in width, and from 1–4 inches in depth. Larvae were found on the sides and undersurfaces of rocks and were frequently attached to *Lycopodium*. Pupae were all found singly on the undersides of rocks. Two adults were collected as they emerged.

Most biological observations on *P. fulvum* have been made by workers in Alaska. Sommerman *et al.* (1955) mentioned that the species was confined to small, cold, tumbling streams. The larvae seemed to prefer the undersides of loose stones, while pupae were found at the edge of, or actually in, the moss that covered rocks. There was one generation a year, and the species overwintered in the larval stage.

Records of *P. fulvum* biting man and other animals have been provided by Hearle (1932) in British Columbia, and in Alaska by McAtee (1922), Sailer (1953), and Sommerman *et al.* (1955). On the other hand, Jenkins (1948), also working in Alaska, observed that females would fly about humans but did not bite.

Prosimulium onychodactylum Dyar and Shannon. Mature larvae of *P. onychodactylum* are generally found from late May until mid-July. They occur in streams varying in width from 1–25 feet or more, with depths of 2 inches to about 4 feet, and with current velocities ranging from less than 1 foot to 8 feet per second. They seem to prefer sandy or silty areas of the streams where there are few rocks but an abundance of vegetation. Larvae tend to become concentrated on the upper or lower surfaces of grass blades and trailing branches, and often congregate on the darker portions of these. On several occasions larvae were found densely grouped on the dark bands of the stems of *Equisetum,* but none were found on the green portions. Jenkins (1948) stated that the larvae and pupae were found commonly on rocks and gravel, especially on light colored rocks with cracks and rough surfaces. Sommerman *et al.* (1955) stated that this species probably overwintered in the egg stage in Alaska, and that hatching appeared to start when the temperature was a degree or two above freezing. This is probably the case in Utah also, because small immature larvae have been collected from water as cold as 37° F. while mature larvae were found in streams in which temperatures averaged between 47–55° F. Judging from the larval collections over a three-year period, there is a single generation per year in Utah, conforming with the situation in Alaska.

No pupae or adults have been taken in Utah. Sommerman *et al.* (1955) mentioned that the pupae seemed to be limited to sandy areas where they attached their sandy and pebbly cases to logs or loose stones, usually at the line of contact with the sand. The feeding habits of the female are not known.

Eusimulium aureum (Fries). *Eusimulium aureum* is widespread over the state and the immature stages can be found in

most streams. The larvae and pupae are generally most abundant in small, warm, rather slow-flowing streams that have an abundance of trailing vegetation.

The female oviposits on leaves, rocks, and sticks, depositing the eggs in a compact mass, one layer deep. DeFoliart (1951) reported that eggs were deposited in such a manner that they stood on end. After hatching, larvae require from two to five weeks for complete development, the time being dependent upon the water temperature (Sommerman *et al.*, 1955; Stone and Jamnback, 1955). Pupae require about a week for full development.

Adults have been collected in Utah from late April to the middle of September. There appears to be a constant overlapping of generations in the Salt Lake Valley, and larvae, pupae, and adults are present almost constantly during the above mentioned period. However, the adults, although rather widely distributed throughout Utah, have not been observed to occur in large numbers at any one time. There are probably three to four generations per year. Jobbins-Pomeroy (1916) reported five to six generations each year in South Carolina, but Davies (1950) in Ontario, and Stone and Jamnback (1955) in New York, reported two annual generations for this species.

The female does not appear to bite man in Utah, and Hocking and Richards (1952) stated that it was only rarely attracted to man in Labrador. Fallis and Bennett (1958) reported that it feeds on birds in Ontario.

Eusimulium baffinense (TWINN). *Eusimulium baffinense* is a rare species in Utah. Mature larvae have been collected only a few times although special efforts were made to find them in 1957 and 1958. Knowlton and Maddock collected one adult male on July 15, 1943, and Dr. Knowlton informed the writer (in litt., 1958) that he had taken the species (no sex or numbers mentioned) in a light trap at Logan, Cache County, on June 30, 1957.

Larvae were collected on several occasions but were all taken from the same stream in Logan Canyon. The stream was about 12 inches wide, 2–6 inches deep, and had a hard, mud botton with a few scattered small rocks. The stream flow was about 2 feet per second and the water temperature was 50° F. An abundance of grass was growing both on the bottom and along the banks. The larvae were attached to the undersides of the trailing grass, and were associated with larvae of *Simulium canadense* Hearle, *Eusimulium aureum, E. canonicolum* Dyar and Shannon, *Prosimulium exigens, P. flaviantennus* (Stains and Knowlton), and *P. onychodactylum*. Collection records obtained by the author in Utah would indicate that the winter is probably passed in the egg stage, and that there is one annual generation. The adult female is unable to bite due to its weakly developed mouthparts.

Eusimulium canonicolum DYAR AND SHANNON. Larvae and pupae of this species have been collected in streams varying from 1–30 feet in width, from 2–36 inches in depth, and having current velocities of 2–6 feet per second. The specimens were collected at elevations from 6,000 to 10,000 feet. The smaller streams had beds of mud and gravel while the larger streams had rocky bottoms. Immature stages were found on trailing grass and willows, dead sticks, and rocks. The stream temperatures varied from 57–63° F. during the period when pupae were present. The species was found in association with *E. aureum, E. baffinense, Simulium arcticum* Malloch and *S. tuberosum* (Lundström).

Observations on the feeding and oviposition habits of this species are presented in another paper (Peterson, 1959).

Eusimulium latipes (MEIGEN). This species has been collected in Utah at elevations from 4,725 to 10,050 feet. In every case, larvae and pupae were found in small spring-fed streams varying from 6–36 inches in width, ½–6 inches in depth, and having current velocities of 1–2 feet per second. These streams all had mud or sand bottoms with a few scattered small rocks, and an abundance of trailing grasses. Several of these streams dried up near the

TABLE 1.—Summary of the preferred larval and pupal habits for nine species of Utah blackflies

Species	Preferred stream types					Preferred substratum		
	Width (ft.)	Depth (in.)	Water velocities (ft./sec.)	Bottom	Max. water temp. during pupal stage	Trailing vegetation	Sticks	Loose rocks
P. exigens	<1–<25	4–24	<1.0–4.3	Mud-gravel, with scattered small rocks	65° F	+	+	++
P. flaviantennus	<1–3	2–24	<1.0–4.5	Mud-gravel; rocky	72° F	+	+	++
P. fulvum	<1	1–4	<1.0	Rocky	65° F	+	—	++
P. onychodactylum	<1–>25	2–48	<1.0–8.0	Silt; sand	—	++	+	—
E. aureum	<1–>25	1–24	<1.0–4.0	Mud-gravel; rocky	70° F	++	+	+
E. baffinense	<1–2	2–6	<1.0–2.0	Mud; mud-gravel	—	++	—	—
E. bicornis	<1	1–2	<1.0	Mud	—	++	—	—
E. canonicolum	<1–30	2–36	<2.0–6.0	Mud-gravel; rocky	63° F	++	+	+
E. latipes	<1–3	0.5–6	<1.0–2.0	Mud; sand with scattered small rocks	65° F	++	—	+

TABLE 2.—Summary of some life history data for nine species of Utah blackflies

Species	Known altitudinal distribution (ft. above sea level)	Number of annual generations	Overwintering stage	Larval associates
P. exigens	4,200–11,000	1	larva	*P. flaviantennus, P. fulvum, P. onychodactylum, E. aureum, E. baffinense, E. latipes, S. canadense, S. piperi, S. tuberosum, S. venustum, S. vittatum.*
P. flaviantennus	2,700–7,000	1	larva	*P. exigens, E. aureum, E. baffinense, S. tuberosum, S. venustum.*
P. fulvum	10,050	1?	larva?	*P. exigens, E. latipes.*
P. onychodactylum	4,250–9,600	1	egg?	*P. exigens, E. baffinense, S. canadense, S. defoliarti, S. vittatum.*
E. aureum	2,625–11,000	3–4	egg	*P. exigens, P. flaviantennus, E. baffinense, E. canonicolum, E. latipes, S. arcticum, S. vittatum.*
E. baffinense	6,000	1?	egg?	*P. exigens, P. flaviantennus, P. onychodactylum, E. aureum, E. canonicolum, S. canadense.*
E. bicornis	7,000	1?	egg?	
E. canonicolum	6,000–10,000	1–2?	egg?	*E. aureum, E. baffinense, S. arcticum, S. tuberosum.*
E. latipes	4,725–10,050	1	egg	*P. exigens, P. fulvum, E. aureum, S. vittatum.*

end of summer. Water temperatures ranged from 47–65° F. during periods when the larvae were mature and pupae were present. Mature larvae and pupae appear during the latter part of May at elevations near 4,725 feet, and have been collected as late as September 11, at elevations near 10,050 feet. Larvae and pupae were found most frequently on trailing grasses, but in very shallow and slow-flowing water, they were usually collected from the undersurfaces of small rocks.

There appears to be but one generation per year in Utah in any given locality; the winter is passed in the egg stage. Sommerman *et al.* (1955) mentioned that there are one or two generations a year in Alaska depending upon stream conditions, and that the winter is passed in the egg stage. This agrees with observations of Stone and Jamnback (1955) in the Adirondacks. Edwards (1920) stated that there was a single generation each year in Britain, but he said the species overwintered in the larval stage.

In Utah, *E. latipes* is not known to bite humans. This agrees with observations by Hocking and Richards (1952) in Labrador, Stone and Jamnback (1955) in the Adirondacks, and Davies and Peterson (1956) in Ontario. In Britain, however, *E. latipes* was reported to feed on humans (Edwards, 1920; Smart, 1944) and cattle (Stewart, 1932). This species was reported to feed on birds in Ontario (Anderson, 1956; Davies and Peterson, 1956; Fallis and Bennett, 1958).

A summary of the preferred larval and pupal habitats, and some life history data for nine blackfly species that occur in Utah, are presented in Tables 1 and 2.

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A METHOD FOR BIOASSAY OF THE EFFECTIVENESS OF RESIDUAL SPRAYING [1]

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INTRODUCTION. The effectiveness of house spraying with contact insecticides of persistent action (DDT and other chlorinated hydrocarbons) depends on a variety of physical factors: the kind of sprayed surfaces, the quality of the insecticide, the technique of application, age of spray deposit, changes of room temperature and humidity, dust and smoke covering the sprayed surfaces, etc., and also on the different response of the insect populations to the toxicant (behaviour, susceptibility, irritability, flight reactions, etc.), such responses depending on many factors and conditions which are beyond the scope of this paper.

Taking into consideration that residual house spraying constitutes a method of insect control in certain sanitary operations, such as antimalaria campaigns, it is of great interest to be able to determine, at any given moment, the amount of insecticide which persists on the sprayed surface after a certain lapse of time—weeks or months—since the house has been sprayed, and to what degree the sprayed surfaces preserve their effectiveness. Chemical tests in some ways answer the first question more or less satisfactorily, but not the second, which from a practical viewpoint is more important. The biological method which we shall describe is not entirely new; however, it combines the characteristics of some methods already in use with the personal experience of the authors and some general ideas which came up in discussions with other members of the C.N.E.P. of Mexico.

MATERIAL. The living material for the proposed bioassay is obtained in or near the village or hamlet where the testing is required, but in neither case in the interior of sprayed houses. The anophelines, for example, can be caught with human or animal bait, or obtained from pupae collected in not too distant breeding places; but preferably, all specimens used in the test and controls should be of the same sex and the same physiologic condition. The most desirable are females, blood-fed some hours before (for instance, baiting them at night and using them for the experiments next morning). Only in special cases can material taken from another locality be used, and this should be pointed out in the reports.

TECHNIQUE. A number of test boxes are located on the sprayed walls or other sprayed surfaces (or on sheets of various materials which had been treated with the insecticide for experimental purposes). We use round boxes similar to Petri dishes, made of transparent plastic material (plastic sheets "cristal acetate" No. 1500). The upper diameter measures 70 mm, the diameter of the lower, open side, which will be put against the surface to be tested, measures 80 mm, and the height is 13 mm (fig. 1). The boxes can be molded in the laboratory, out of a plastic disk of approximately 105 mm, while still hot. On the upper side a circular orifice has been cut, through which the mosquitoes (for instance 10 anophelines) can be introduced and which is closed by a disk of the same plastic material, fixed to the box with two small strips of adhesive tape (fig. 1, B). Numerous small perforations are made on the upper side with a slightly warmed pin to provide an outlet for the air stream with which the mosquitoes are blown into the box from the suction tube used for catching them. Furthermore, they serve

[1] This study was carried out as part of the research program of the National Commission for the Eradication of Malaria, Ministry of Public Health and Welfare, México, D. F.

to avoid the accumulation of humidity in the box and to prevent the concentration of gas, in the case of testing the effectiveness (by contact) of a surface treated with an insecticide (e.g., dieldrin) which may have a certain fumigation effect also.

The edge of the box has a brim, approximately 3 mm wide (fig. 1, A); with this brim the box can be fixed to the surface which is to be tested, by pins or thumbtacks. The boxes used for the controls can be fastened by rubber bands (fig. 1, E) to pieces of cardboard, which in the case of "experimental controls" (see below, The Testing Method) have previously been lined with disks of paper or cloth impregnated with a definite amount of insecticide, and in the case of "net controls" with disks impregnated only with the solvent used for the insecticide of the experimental control.

The disks treated with insecticide for

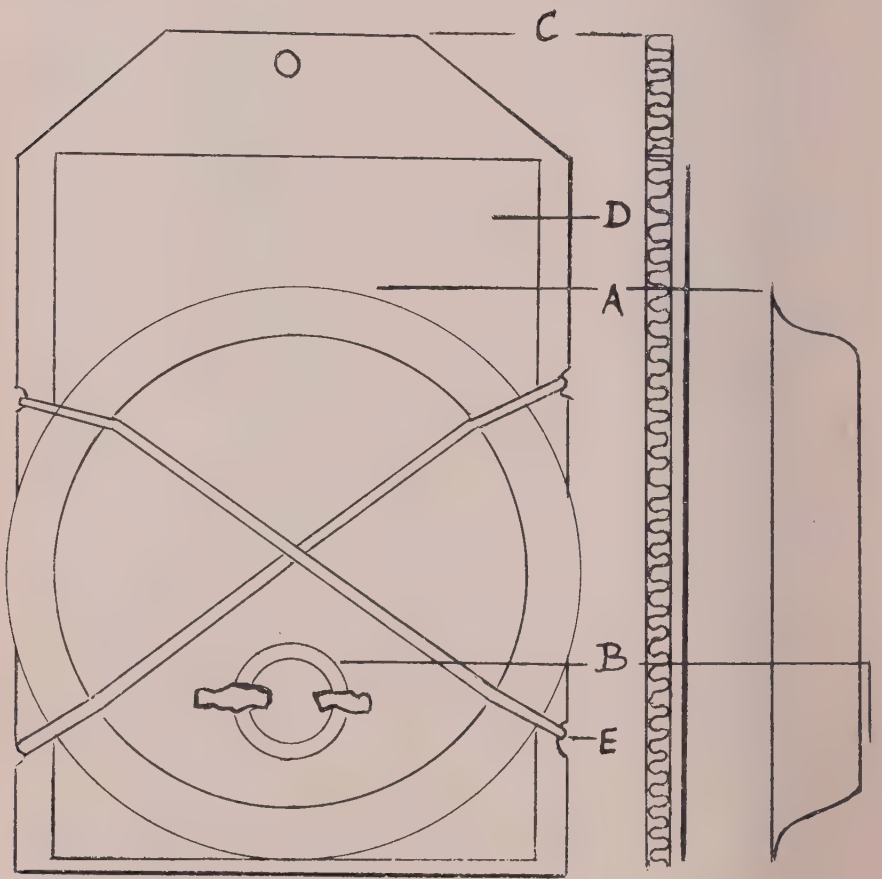

FIG. 1.—Frontal and lateral views of a testing box fixed onto a piece of corrugated pasteboard. A, brim of the box of transparent plastic material. B, hole for putting in mosquitoes and circular plastic cap fastened with two strips of adhesive tape. C, piece of corrugated pasteboard. D, disk of cloth or paper, which is prepared for the net control without insecticide, for the experimental control with insecticide. E, rubber bands.

the experimental control may be sheets of cotton cloth or of slightly absorbent (mimeograph) paper impregnated with a dose of insecticide smaller (e.g. 50 percent) than that which theoretically should have been applied to the wall or similar surface to be tested, in order to make the experiment under sufficiently severe conditions.

THE TESTING METHOD. The test is a triple test. Following Downs, Bordas and Navarro (1951) and Gómez Mendoza (1958), adequate insect samples, in our case anophelines, are exposed: (a) to the action of the insecticide on the sprayed wall or similar surface the efficiency of which is being investigated (accurately speaking: the *test*), (b) to the action of the insecticide on a surface (piece of paper or cloth) purposely treated with a known amount of insecticide (*experimental control*), and (c) to all conditions of the test except the action of the insecticide (*net control*).

The exposure time for the mosquitoes is not an arbitrarily fixed one as commonly used in other methods. In the tests as well as in the experimental controls, the exposure time will be the time necessary to produce the knock-down of the individuals, (at which time the specimens tested on vertical surfaces lose the contact with the insecticide). However, when a 100 percent knock-down has taken place only in the experimental control, the time of exposure in the test must be prolonged for such a lapse of time as will be considered sufficient, according to the species, to come to the conclusion that the insecticide is no longer working.

But we do not limit our observations to stating the time when, for instance, all 10 specimens which had been introduced into the test boxes had been knocked down (*total knock-down*). During the experiments the number of insects knocked down in each box is counted at regular intervals which are established in accordance with the species, the insecticide used and the particular conditions of the experiment. Working with *Anopheles albimanus, A. aztecus* and *A. quadrimaculatus* we found it practical to count the mosquitoes which were knocked out every 20 minutes during three hours. Thanks to these counts at regular intervals, the exposure time as well as the proportion of the insects which are knocked down more quickly or more slowly, can be determined more accurately. This is necessary because the observation of a total (100 percent) knock-down within two equal periods can conceal significant differences; for examples, the fact that 90 percent of all individuals should be knocked down in the first minutes of exposure and the remaining 10 percent should go on living for a long time without any sign of intoxication, and the other fact that only 10 percent should be knocked down quickly and 90 percent go on without being affected for a long time.

When exposure time is terminated, that is, usually when total knock-down has taken place, the mosquitoes are kept for possible recovery in cages, glass jars lined with a thin layer of gypsum, or drinking cups made of stiff waxed cardboard with a sleeve or surgical gauze, provided with the usual sugar water nourishment; in these containers the mortality count is made 24 hours later, in order to state an eventual recovery rate of knocked down individuals, or a retarded lethal effect on a specimen which had not been knocked down previously.

The number of test boxes to be collected on the sprayed surfaces and of controls can vary with the living material at our disposal, the number of dwellings or other rooms to be tested, and other circumstances; but it is advisable to have a number of experimental and net controls which should add up to the number of tests. A minimum of four tests should be made in each room. Every box, regardless of either being destined for the test itself or the experimental or the net control, should contain 10 specimens.

DISCUSSION. The method will be useful to estimate the persistency of the effect of the insecticide on the mosquitoes of the respective locality and under the environ-

mental conditions of that place. The simultaneous arrangement of test and experimental control will enable us to detect any decrease of the effectiveness of the insecticide deposit (survival in the test; mortality in the experimental control) and, furthermore, to discover differences which would indicate a decreasing susceptibility (considerable survival not only in the test but also in the experimental control).

However, the observation of exposure times to provoke a knock-down, longer than usually necessary for the same species, and of low mortality rates, both in the tests and in the experimental controls, can be valued only as circumstantial evidence that a decrease of susceptibility might have developed in the insect population. Such evidence will require subjecting the insects of that locality to the precise susceptibility tests which have been established for investigating the "resistance problem"; in the case of mosquitoes, for example, the WHO test.

SUMMARY. The method presented in this paper has been intended for the study of the residual effect of insecticide applications under the local conditions of the sprayed houses. The method will be useful to detect any failure of effectiveness of the insecticide and may also afford a rough estimation of the grade of susceptibility of the local insect population which is supposed to be controlled.

Circular boxes of 80 mm of diameter, made of transparent plastic material, were used to expose at the same time in each box groups of ten specimens of insects gathered from the same source: (*a*) to the action of a surface which had received the routine spraying ("test"), (*b*) to the action of a piece of paper or cotton cloth which had been treated with a definite amount of the insecticide ("experimental control"), and (*c*) to the conditions of the test without the toxicant ("net control").

The observations are made by registering at regular intervals the time in which knock-down takes place and recording the corresponding mortality rates within the following 24 hours. In the tests made with *Anopheles albimanus, A. aztecus* and *A. quadrimaculatus* it was found suitable to observe the knock-down rate every 20 minutes.

ACKNOWLEDGMENTS

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RESIDUAL SPRAYS FOR THE CONTROL OF *ANOPHELES QUADRIMACULATUS* IN BUILDINGS

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Spraying the interior of buildings with insecticides to kill the adults of *Anopheles* mosquitoes has been widely used as a malaria control measure since the end of World War II. In recent years there have been many reports that serious resistance has developed to DDT and other chlorinated hydrocarbons. Brown (1958) in his review of the literature on this problem presents evidence that physiological or behavioristic resistance to one or more of these insecticides has become widespread throughout the world. Other and more effective insecticides are therefore needed to insure an effective, continuing campaign to eradicate malaria.

Laboratory tests conducted by LaBrecque *et al.* (1958) and Gahan *et al.* (1959) indicated that malathion, Diazinon, dicapthon, ronnel (Korlan, Dow ET-57), barthrin, and 2,4-dimethylbenzyl chrysanthemumate had sufficient residual durability and toxicity to serve as substitutes for the chlorinated hydrocarbons. To obtain more information on these materials under conditions of practical use, a series of tests was conducted in the vicinity of Stuttgart, Arkansas, during the summer of 1958 in buildings naturally infested with adults of *Anopheles quadrimaculatus* Say. DDT was included as a standard.

Stuttgart is in one of the principal rice-growing areas in the United States, and there are many large fields flooded with water from May until September. *Anopheles* breeding starts early in the growing season and reaches a peak during the latter part of August or early in September. Adult mosquitoes are prevalent throughout the summer in buildings that house animals or are close to their pasturages, but are usually not numerous on farms without livestock.

Only small buildings on farms having livestock were used in this study. Most of them were chicken houses or barns that housed animals each night, but some pump houses, sheds, garages, and privies close to areas where cattle or chickens fed regularly were also used. All were constructed of wood, and several had a portion of the inside surface covered with tarred paper. Since spider webs provide resting places for *Anopheles* adults and the spray did not adhere to them as well as to the wood, those that could be removed easily were eliminated before spraying. In some buildings the spiders built new webs after the insecticides had been applied, and mosquitoes were sometimes found resting on them.

Emulsion sprays were applied on the interior walls, ceilings, and any pieces of equipment that were present. The exterior surfaces and areas under the eaves were left untreated. Applications were made with a compression sprayer that had an adjustable nozzle with a flat fan cap. All but two of the sprays were prepared from concentrates containing 25 percent of the toxicant, 65 percent of xylene, and 10 percent of Triton X-100 (an aralkyl polyether alcohol). The others were commercial preparations containing 25 percent of Diazinon or 50 percent of malathion. Just enough material was placed in the sprayer to treat a single building at the desired dosage. Between July 14 and 23 each material was applied to three or four buildings at the rate of 200 mg. per square foot. These sprays contained 2.5 percent of toxicant. Between August 4 and 7 barthrin and 2,4-dimethylbenzyl chrysanthemumate were applied to two additional buildings at 200 mg. and to three or four others at 400 mg. per square foot. These sprays contained 5 percent of toxicant. On August 11 Diazinon and malathion were

TABLE 1.—Effect of insecticide residues on mosquito densities in buildings during the afternoon

Dosage (mg./sq. ft.)	Type of Building	Pretreatment Count	Percent Reduction at Indicated Intervals after Treatment Weeks						
			1	2	3	4	5	7–8	10–11
Malathion									
50	Shed	373	98	89	—	92	—	99.4	—
		496	99.8	99	—	90	—	99.3	—
	Chicken house	276	99.6	97	—	91	—	63	—
200	Chicken house	677	100	100	100	100	100	97	99
		329	100	100	100	100	100	95	98
	Garage	612	100	100	100	99.7	99	100	99
Diazinon									
50	Horse stable	975	100	98	—	36	—	—	—
		537	100	86	—	6	—	—	—
	Chicken house	354	100	97	—	8	—	—	—
200	Garage	1100	100	100	—	100	100	96	99.9
		299	100	100	100	100	99.3	3	—
	Chicken house	675	100	100	100	99.7	99.7	61	—
DDT									
200	Chicken house	177	100	100	97	97	95	93	50
		629	100	99.7	99	97	94	79	91
	Cow barn	1570	98	72	79	76	44	—	—
Dicapthon									
200	Chicken house	620	100	99.5	98	99.6	88	0	—
	Privy	207	100	99.5	86	99	90	0	—
	Pump house	136	100	100	100	99.3	97	7	—
Ronnel									
200	Cow barn	5250	99.9	99.9	62	0	—	—	—
	Sheep fold	1445	100	100	84	48	24	—	—
	Horse stable	451	100	100	99.6	98	91	49	—
2,4-Dimethylbenzyl chrysanthemumate									
200	Pigsty	407	85	98	49	0	—	—	—
	Chicken house	248	100	99.6	80	63	0	—	—
		328	99.1	75	10	—	—	—	—
		1125	99.6	95	68	—	34	—	—
	Shed	396	99.7	99.5	73	59	10	—	—
	Pump house	192	100	97	97	—	88	96	—
400	Chicken house	237	100	98	90	—	61	—	—
		212	100	97	86	—	27	—	—
		412	100	99	92	—	84	97	—
	Dog house	345	100	99.7	100	—	98	99	—
Barthrin									
200	Chicken house	182	91	90	0	0	—	—	—
	Cow barn	1537	98	97	90	11	—	—	—
		910	97	83	0	—	—	—	—
	Shed	305	99	55	48	—	—	—	—
	Pump house	225	100	98	—	91	88	93	100
400	Chicken house	725	99.7	98	83	—	97	95	—
		348	100	98	83	—	74	95	—
	Pigsty	945	100	99	95	—	91	99.4	—

applied in 1 percent emulsions to three buildings at 50 mg. per square foot.

The effectiveness of these treatments was determined by making pre- and post-treatment counts of the *Anopheles* adults seen in the buildings. Before a building was selected two afternoon observations were made. If the infestation exceeded 100 *Anopheles* both times, the building was used in the test. In buildings where the number exceeded 500 it was impossible to obtain an accurate count, for mosquitoes moving from one spot to another disturbed those in the vicinity; therefore, 50 or 100 were counted to assist in making estimates of the total number present. Most of the post-treatment observations were also made during the afternoon, to allow the insecticide time to affect the mosquitoes. Between August 4 and 20 all the buildings that were free of mosquitoes in the afternoon were visited on 1 or 2 days within an hour after sunrise to ascertain if *Anopheles* were entering the buildings and resting on the treated surfaces. Repeat visits were made the same day at hourly intervals until all mosquitoes left or it became obvious that some of them would remain until the afternoon. All the interior surfaces were examined with the aid of a flashlight. Particular attention was paid to the corners of the room, the inside and under side of chicken nests, the inside of empty boxes or feeding troughs, and other places where the light intensity was low, as they were the favored resting areas. On hot days most of the mosquitoes were on the lower part of the wall and none on the ceiling, but on cool days they preferred the ceiling and upper part of the wall. Most of the mosquitoes in these buildings were *Anopheles quadrimaculatus*. An occasional *Psorophora* was seen, but it was never included in the counts. The percent reduction was determined from the number of mosquitoes observed before and at various intervals after treatment.

During the latter part of September the rice fields were drained. The nights became sufficiently cool so that the mosquitoes encountered were sluggish. Low counts were obtained on September 29 in many of the sprayed and unsprayed buildings, showing the end of the mosquito season was approaching rather than an increase in effectiveness of the residues. The experiment was discontinued on that date. By that time the age of the treatments ranged from 7 to 11 weeks.

The results are given in Table 1. The most effective materials were malathion and Diazinon. Not a single mosquito was found during the afternoon throughout the first 3 weeks in any of the buildings sprayed with these materials at 200 mg. per square foot and only a few were found the fourth and fifth weeks. The malathion continued to show 95–99 percent reduction throughout the 10–11 week observation period, but by the seventh or eighth week the protection had disappeared in one of the buildings sprayed with Diazinon and decreased to 61 percent in another. Observations made within 1 hour after sunrise demonstrated that neither of these chemicals was highly repellent. More than 50 and as many as several hundred mosquitoes that landed readily on the treated surfaces were seen in each of the buildings. As early as the third and fourth weeks malathion appeared to be the faster acting material, because it cleared the buildings of mosquitoes by 8–9 a.m. A few mosquitoes were still present at that time in the buildings sprayed with Diazinon, but they disappeared by 10–10:30 a.m. Neither of these compounds was as satisfactory at a dosage of 50 mg. per square foot as at 200 mg. Some *Anopheles* adults were found in the afternoons of the first week in the buildings treated with malathion and the second week in those sprayed with both compounds. Counts were so high by the fourth week in the three buildings treated with Diazinon that no further observations were made, but reductions above 90 percent were maintained in two of those treated with malathion throughout the 7-week period.

In contrast to the results with malathion and Diazinon, mosquitoes were found as early as the third week in all the buildings sprayed with DDT at 200 mg. per square foot. The reduction in one cow barn was less than 100 percent the day after treatment and less than 80 percent by the second week. Although the other two treatments were considerably more effective, on one occasion between the eighth and eleventh weeks the protection dropped to 79 percent in one of the buildings and 50 percent in the other. After the fifth week it was never above 95 percent in any building.

Dicapthon and ronnel also were highly effective in all buildings for at least 2 weeks. Two of the ronnel treatments then lost their toxicity rapidly, but the residue in the horse stable gave at least 98 percent protection for 4 weeks. This building was about half a mile from the closest rice field, which reduced considerably the population pressure. Mosquitoes were entering the stable during this period, however, for about 100 were seen one morning within an hour after sunrise, over half of which were on treated surfaces. By the seventh week this treatment had lost about 50 percent of its effectiveness. The privy sprayed with dicapthon contained 28 mosquitoes in the third week, but most of them were on a recently constructed spider web. By the fifth week two of the dicapthon treatments were losing their toxicity rapidly and by the seventh week all three were ineffective.

Barthrin and 2,4-dimethylbenzyl chrysanthemumate were the least durable. At 200 mg. per square foot both failed to give complete protection during the afternoon for 2 weeks in any of the buildings, and most of the treatments were less than 90 percent effective within 3 weeks. Increasing the dosage to 400 mg. per square foot improved the protection obtained, but the two materials still lost their effectiveness faster than the 200-mg. deposits of Diazinon or malathion. While it remained effective, 2,4-dimethylbenzyl chrysanthemumate, which laboratory tests have shown to be particularly quick in knockdown, did reduce annoyance more than at least four of the other compounds. Two weeks after application the number of *Anopheles* mosquitoes found within an hour after sunrise in buildings sprayed with this insecticide at 400 mg. per square foot ranged between 2 and 12, as compared with more than 75 in those sprayed with barthrin at 400 mg., 150 in those with malathion at 200 mg., and 250 in those with Diazinon and DDT at 200 mg. Early-morning counts were not made in the buildings treated with ronnel and dicapthon. Counts made soon after sunrise should indicate the maximum densities that will be present at any one time, as *Anopheles* adults seek their daytime resting places at that time.

Although malathion was superior to DDT in these tests, it may not be more effective against other species. A comparison of the results obtained with DDT in this experiment and the one conducted in 1944 (Gahan and Lindquist 1945) shows that the present treatments were considerably less effective. In 1944 deposits that averaged 208 mg. per square foot reduced the infestation more than 99 percent for 3½ to 4½ months, whereas none of the present treatments produced this degree of protection after the third week. Possibly the practice by many farmers of scattering dusts containing a combination of DDT and BHC on lawns and around barnyards to obtain relief from mosquitoes has caused some resistance to develop.

SUMMARY.—Malathion and Diazinon were the most effective of seven chemicals applied as residual treatments to buildings containing natural infestations of *Anopheles quadrimaculatus* Say. At 200 mg. per square foot both compounds gave 100 percent reduction for 3 weeks and malathion gave 95 percent to 99 percent reduction throughout the remainder of the 10- to 11-week observation period, but by the seventh or eighth week Diazinon had

lost considerable effectiveness. Observations made within one hour after sunrise demonstrated neither chemical was highly repellent. The DDT standard gave less than 95 percent reduction after the fifth week. Dicapthon and ronnel (Dow ET-57, Korlan) were highly effective for at least 2 weeks and partially effective for 4 to 5 weeks. Barthrin and 2,4-dimethylbenzyl chrysanthemumate were the least durable of the group, but while it remained effective, the latter compound acted very quickly.

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NEW MOSQUITO RECORDS FOR NEW JERSEY [1]

PAUL P. BURBUTIS [2] AND ROBERT W. LAKE [3]

Four species of mosquitoes have recently been found by the authors in New Jersey that have not previously been reported from the state. These are: *Aedes implicatus* Vock., *Aedes dorsalis* (Meigen), *Psorophora varipes* (Coq.) and *Culiseta minnesotae* Barr.

Dr. Alan Stone of the U. S. National Museum has further confirmed the identification of the above four species.

With the addition of these four species the New Jersey state list of mosquitoes now totals 49.

Aedes implicatus Vock. During 1957 the authors found three mosquito larvae in the New Jersey Agricultural Experiment Station Museum's larval collection labeled *Aedes impiger*. Since this species has not previously been recorded from New Jersey, the specimens were examined. They did not fit the description of *Aedes impiger* or any other New Jersey species familiar to us at that time.

On closer examination the specimens were determined to be *Aedes implicatus* Vockeroth. *Aedes impiger* (of authors, not Walker) which is a far northern and western species, is also a synonym for *Aedes implicatus*.

These larvae were collected by E. J. Hansens on April 8, 1946 from Netcong, New Jersey, and the original determination (*A. impiger*) was by Matheson.

Aedes dorsalis (Meigen). During the course of identifying routine mosquito trap collections from Passaic County, New Jersey, one female specimen of *A. dorsalis* was encountered. The specimen was collected from Clifton, New Jersey on July 26, 1957.

Since *A. dorsalis* is reported from states surrounding New Jersey (New York, Delaware, Pennsylvania, Connecticut and Massachusetts) it is conceivable that this species could breed to a limited extent within the state or that the specimen entered New Jersey from an outside breeding

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source. Attempts to locate local breeding have not been successful, and trap collections during the 1958 season have not yielded additional adults of this species.

Psorophora varipes (Coq.). One female of this species was collected on July 8, 1957, from West Milford, New Jersey. It was hand-collected while biting in a hemlock-rhododendron forest. To date no larvae have been collected in New Jersey and no light trap collections of this species have been reported.

Culiseta minnesotae Barr. During the summer of 1956 regular light trap collections of mosquitoes were made at Upper Greenwood Lake, New Jersey, in conjunction with studies of *Culiseta melanura*. An unusual number of what was first recognized as *C. morsitans* were collected but upon further investigation it was found that these specimens only superficially resembled *C. morsitans*. They were *Culiseta minnesotae* a new species recently described by A. R. Barr in August 1957.

A total of 318 female specimens were collected with 293 of these being taken during the last two weeks of July. Only one larva, from several hundred larval specimens collected from various bogs in the state, proved to be *Culiseta minnesotae* as described by Price, 1958. This specimen was collected by H. C. Chapman from Tuckahoe (South Jersey) on June 2, 1955.

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OPERATIONAL AND SCIENTIFIC NOTES

Observations on the Operation of Mosquito Light Traps with a Cylindrical Vertical Screen. One of the problems in the operation of light traps by mosquito control agencies is the amount of time required for sorting collections and separating mosquito specimens from heavy accumulations of other, unwanted, insects. Mulhern, in a paper presented before the American Mosquito Control Association at Salt Lake City in 1952, proposed the use of a cylindrical vertical screen of a quarter-inch hardware cloth fitted around the top of the trap cylinder and extending up to meet the underside of the hood, as a means of excluding larger insects.

An experimental trap fitted with this type of screen was operated in the latter part of July of 1958 simultaneously with the regular trap on a location here in Nassau County where the numbers of beetles as well as other insects had been particularly heavy in trap cups since early June. The test trap and the regular trap conformed in every way to Mulhern's specifications and were operated five feet apart for the same period each night for eleven nights. The regular trap, however, was fitted with the old type flat screen. A daily count of the two largest groups occurring in the collections, beetles and moths, was kept along with a rough count of other smaller insects and, of course, the careful count of mosquitoes. The nightly average collection of miscellaneous insects in the test trap during the eleven-night period was 215. The nightly average of insects in the regular trap in this same period was 580.

Five beetles per night was the average number caught in the test trap with an average of nine in the regular trap. The larger species, June beetles and others, were by this time of the season scarce in every trap, and the collections were affected by the fact that even the smaller species such as the Asiatic garden variety were past their peak in the adult stage. It was noted that one beetle slightly larger than the Oriental and Asiatic kinds persisted in collections in both traps. It was identified by Prof. J. Alfred Adams of the New York State Agricultural Experiment Station at Poughkeepsie as the northern masked chafer, *Cyclocephala borealis*, a turf-destroying pest occurring in great numbers in and around New York City and Nassau County.

Moths also are unwelcome invaders in mosquito light trap collections. During the test period an average of 105 moths was noted for each night in the regular trap. The average caught in the test trap was thirty.

Collections of all insects in the regular trap in the five-day period before the test trap was installed averaged 480 per night and on the night before the test began 66 beetles and 121 moths were caught. These counts seem to indicate that the cylindrical vertical screen helped to exclude miscellaneous insects more efficiently than the old type flat screen.

There was, however, an apparent proportional reduction in the number of adult mosquitoes caught in the test trap. The total collected in the eleven nights in the test trap was 99, including 91 *C. pipiens*, 7 *A. vexans* and 1 *A. sollicitans*. The regular trap collected 194, comprising 176 *C. pipiens*, 13 *A. vexans* and the rest *A. sollicitans*. Thirty-six male adults were taken in the regular trap in the period as compared to 26 in the test trap. Mosquito collection, therefore, in the test trap totaled about 50 percent of collection in the regular trap. Miscellaneous insect collection was reduced by the cylindrical screen by approximately 63 percent and the larger insect collection was reduced by more than 74 percent.— R. J. Hemmings, Nassau County (N. Y.) Department of Public Works.

A Note on the Larvae of *Anopheles subpictus* and *sundaicus*. The larvae of *Anopheles subpictus* Grassi and *An. sundaicus* Rodenwaldt have usually been regarded as more or less indistinguishable, though several attempts have been made to separate them (see Bonne-Wepster and Swellengrebel, 1953). Gater (1934), writing of Malaya, concluded that "for practical purposes the larvae of *A. subpictus malayensis* Hacker and *A. sundaicus* cannot be differentiated with certainty." However, Christophers (1933, p. 247) refers to Ghosh's (1932) finding that in *sundaicus* mesothoracic hair 5 usually has 3 branches arising near the base, while in *subpictus* it usually has 2, only rarely 3, and they may arise anywhere along the length of the hair. Preliminary examination here by Mr. A. Ganapathipillai seemed to show that this character might be useful, but when a larger number of larvae, raised from eggs laid in the laboratory, were examined by Mr. Chee Sinn Lim a number of intermediates were found. There the matter rested until an opportunity arose to have some more specimens examined by a Zoology student from the University of Malaya, Mr. Ow-yang Chee Kong.

The combined results of these examinations and a few more of my own showed that in 108 specimens of *subpictus malayensis* the number of branches on mesothoracic hair 5 varied from 1–3 and was usually 2; only about 12 percent (13 specimens) had 3 branches on one or both hairs and then the third branch was usually small, arising about half way along the hair. In 86 specimens of *sundaicus* the number of branches varied from 2–4 and was most often 3, usually arising near the base of the hair; only about 10 percent (9 specimens) had 2 branches on both hairs. Thus Ghosh's findings are confirmed and the following couplet should identify the majority of the larvae of Malayan specimens of either species.

Mesothoracic hair 5 usually with 3 branches on one or both side, arising near the base.—*sundaicus*

Mesothoracic hair 5 usually with 2 branches or simple, if with 3 branches on one side (rarely on both) the third branch is small, arising about half way along the hair.—*subpictus malayensis*

The larvae examined come from various parts of Malaya; those of *subpictus* from fresh water near Kuala Lumpur, and from near the sea in Province Wellesley and on Penang Island; those of *sundaicus* from Selangor and Perak on the west coast, and Tioman island off the east coast.

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—J. A. Reid, Institute for Medical Research, Kuala Lumpur, Federation of Malaya.

FRESHWATER PLANARIANS (FLAT-WORMS) AS PREDATORS OF MOSQUITO LARVAE. In this Institute the early stages of the mosquito *Mansonia* (*Mansonioides*) *uniformis* are raised in a guinea-pig dung infusion in large glass jars, with the larvae and pupae attached to the roots of the water hyacinth *Eichornia crassipes* (Wharton, 1957). The plants are removed and washed when about 10 days old, and the larvae are counted and placed in a new jar with fresh infusion. On one occasion very few larvae were found and a search for the usual predators, may-fly and dragon-fly larvae, was unsuccessful, but several planarians (flat-worms) were found. They were placed in clean water with a few *Culex pipiens fatigans* larvae which they killed, withdrawing the body contents and leaving only crumpled, tangled larval skins. Authorities on planarian worms state that they will eat any animals they can capture but that they are unable to capture active swimming animals although the latter may sometimes get entangled in the mucous trials left by the planarians and thus fall victims. Further observations showed that the larvae were in fact usually trapped in this way but occasionally a larva at the surface of the water was directly attacked and captured. One Stage II larva of *C.p. fatigans* was seen to be caught in this way, the planarian attaching itself by a lateral extension of the head. The larva and planarian then fell to the bottom of the dish and while the planarian was sucking out the body contents two more larvae became entangled in the mucous trails and were drowned.

Predation by planarian worms on mosquito larvae has been reported previously by Lischetti (1919), who observed in Brazil that 6 planarians disposed of 106 out of 108 *Culex* larvae in four hours. In the present observations the planarians were less efficient, but still disposed of quite large numbers of larvae. In one experiment with one planarian to five larvae, 10/20 Stage IV and 13/20 Stage III *C.p. fatigans* larvae were eaten in a period of 24 hours. Since *Mansonia* larvae remain attached to the roots of plants one might expect them to be more susceptible to the attacks of roving planarians. However, in experiments similar to those with *C.p. fatigans* it was found that only 7/20 and 5/20 Stage III and IV *M. uniformis* larvae attached to the roots of *Pistia* plants were killed. Van den Assem (1958) has recently shown that *Mansonia* larvae are less subject to attacks by insect and fish predators when they are attached to the roots of plants than are the more motile larvae of *C.p. fatigans*. Direct observation showed that the *Mansonia* larvae "freeze" when a planarian is nearby and one was seen to pass over such a larva without attacking it. Predation by these flat-worms was therefore unlikely to have been the cause of the reduction in numbers of larvae which led to these observations.

The flat-worms varied in size from about 4 to 7 mm. in length, the largest when fully extended being about the size of a Stage IV *C.p. fatigans* larva. I am indebted to Dr. S. H. Chuang of the University of Malaya who identified specimens as belonging to the genus *Planaria*. As suggested by Dr. Libbie Hyman to whom the observations were referred, the predatory habits of the planarians are of little practical significance. If they could be established in breeding places such as treeholes they might reduce the output of mosquitoes, but the few observations which were made with planarians in bamboo pots showed that adults of *Aedes albopictus* continued to emerge despite their presence.

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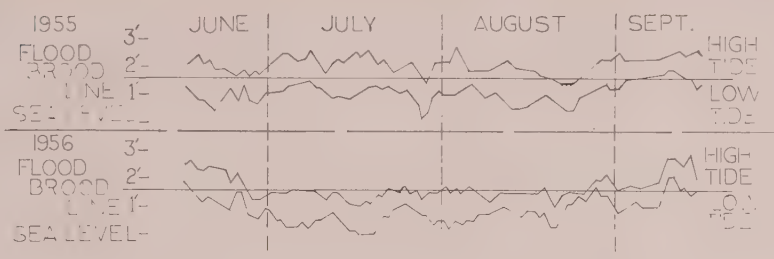
—R. H. Wharton, Institute for Medical Research, Federation of Malaya.

A NOTE ON SALT-MARSH MOSQUITO BREEDING. During the past several years, the Jefferson County (Texas) Mosquito Control District has maintained graphs correlating the results of light trap catches, rainfall, wind direction, wind velocity and tides. It was noted that during the summer preceding a heavy flight of salt-marsh mosquitoes, the general tide level was significantly lower than during the summer preceding limited salt-marsh flights.

FIGURE 1



By inspection of the graphs a line was drawn. The line was located just above the high, high tide level of those years having heavy, fall, salt-marsh mosquito flights. In our particular case, the "flood brood" line is at 1.6 feet above mean sea level.

The elevation given for our coastal marshes in Coast and Geodetic Survey quadrangles varies from one to two feet above mean sea level.

The "flood brood" line exists only as an abstraction on paper. Work is underway in three plots in our marshes to establish it in the marshes, if possible.

The tide gauge from which the readings are obtained is located on the ship channel at Port Arthur, and is maintained by the Corps of Engineers. The gauge is about fifteen miles inland from the Gulf of Mexico, and about six miles upstream from the mouth of Sabine Lake.

Sabine Lake is a large, shallow, salty lake that is about twenty miles long by eight miles wide. The ship channel and Sabine Lake are fed by the Neches and Sabine Rivers. It can be seen readily that the tide gauge does not reflect the extreme tides that would be registered if the gauge were in the Gulf of Mexico. There is also the possibility that the tide gauge is influenced by rainfall from the Neches and Sabine River water shed areas.

The two rivers involved drain a triangular area roughly bounded by Dallas, Texarkana, and Port Arthur. However, Sabine Lake serves to absorb floods and helps to stabilize the water in the ship channel. There is no definite correlation between tide levels and local rainfall.

In the accompanying graphs (Fig. 1) you will note that throughout the summer of 1955 the high tide line remains essentially above the "flood brood" line. In 1956 the high tide drops below the "flood brood" line on June 27 and remains below the line until August 26. In 1955 there were only limited salt-marsh flights. In 1956 there were bad swarms of salt-marsh mosquitoes through September and into October.

The years 1955 and 1956 were picked as typical examples. Similar conditions exist for each year, the records beginning in 1950.

The author is indebted to Professor Emeritus E. S. Hathaway and Mr. Austin W. Morrill, Jr. for their assistance. Correspondence relative to the "flood brood" line is earnestly invited.—George A. Thompson.

A SWATH MARKER FOR SPRAY PLANES USING OIL SPRAYS. The pilot for the Jefferson County Mosquito Control District observed that the major difficulties encountered where (1) judging drift and (2) swath width in marshes and wooded areas. Due to the lack of significant land markers in many areas where the District is forced to spray, it was often difficult to space properly the swaths to achieve maximum efficiency. In some areas the swaths are ten miles in length. The inaccessibility of the marshes to ground personnel denies to the pilot the use of flag men. The lack of ground observers places the entire responsibility of judging swath width, drift, and fall-out on the pilot.

The District uses oil sprays at the rate of one quart per acre which leaves a swath that is invisible to the pilot after executing a turn. In order to improve operations a small thermal aerosol generator was developed. At the end of a swath run the pilot injects a small amount of oil into the exhaust stack of the Piper, leaving behind a marking cloud of white fog.

The apparatus is quite simple to build and easy to install. Normally there is no call to use the fog markers except when the plane is spraying. Therefore, it was decided to use the spray mixture for producing the fog. This arrangement provides ample pressure and obviates a special fog oil supply. A pipe fitting was secured to the spray boom under the belly of the ship. From this fitting a quarter-inch copper tube runs to a point on the pump brackets where it enters a quick operating, self-closing, oil type, valve equipped with a pull lever. From the valve the copper tube continues into a spray nozzle fitted into a 15-inch extension secured to the regular exhaust stack of the Lycoming 150 engine which powers the airplane.

The spray nozzle is a non-clogging type such as is used in Buffalo Turbines and has a 1/32 inch opening. The pump mounting on our particular ship is so designed that the copper tube from the

spray boom to the valve is conveniently supported by the pump bracket. The distance from the valve to the exhaust stack is short and the tube requires no additional bracing.

It is advisable to provide a 360° loop in the line between the valve and the exhaust stack to absorb vibration. A standard automobile type flexible dashboard choke control is brought up through the belly of the ship and the handle mounted conveniently in the cockpit. The self-closing valve relieves the pilot of the task of closing the valve after he marks his swath, and also prevents accidentally leaving the fog generator operating. The pilot has found that in addition to marking his swaths the smoke provides him with an excellent indicator of drift. By laying down about a 100 yard line of smoke he can observe the inversion of the air where he is working.

The Jefferson County District operates a Piper PA 18A, 1958 model, equipped with the Sorenson spray system. It is believed the same principle can be applied to any spray plane using oil sprays.—W. C. Grayson and G. A. Thompson.

EDITORIAL

Once again the Editor wishes to take editorial space to mention current contributions which he feels merit especial attention.

First, all AMCA members should read the minutes of the Annual Meeting, pages 105–123. Attachment #15, p. 118, which is the report of the Committee on Research and Development contains, by implication, a frightening list of things about which we know too little.

The Editor is constantly stressing the fact that we try to keep *Mosquito News* a balanced publication, with articles which pertain to every type of activity concerned with mosquitoes and their control. This issue carries three papers in as many fields, which because of certain outstanding or unusual features, are worthy of special mention. All three were presented at the annual meeting. The first, "The Mosquitoes of Utah" by Lewis T. Nielsen and Don M. Rees, is a model of its kind in content, presentation and particularly in the illustrations which, unfortunately, cannot be reproduced here. The color transparencies which illustrated the paper as presented were not only exactly right to show the habitats of the species, but were pictorially so beautiful that they elicited enthusiastic comment, concurred in by all, from Dr. Louis Williams.

The second paper which we wish to cite is the one by Dr. W. M. Hoskins, "Factors Involved in the Development of Resistance to Insecticides and Some Measures to Reduce Its Effect," (p. 52). Dr. Hoskins has succeeded in making an exceedingly complex subject seem understandable and reasonable. Whether or not we are directly involved in the subject, it is one on which we should all be informed, and Dr. Hoskins' paper is one of the most clearly stated expositions of the subject that has come to our attention.

The third paper, "Increased Efficiency Through Use of Barge to Float Dragline or Clam Shell Crane," is by V. S. Minnich. The Editor has repeatedly asked for more contributions directly from the field of control operations, and Sam Minnich's contribution is cited as an example of an exceptionally lucid and complete description of an aid to control operations. Like the first paper mentioned above, it was illustrated by fine color transparenices which, with Sam's side remarks, make this paper, too, a model of its kind.—D.L.C.

MINUTES OF THE 15th ANNUAL MEETING OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION

Salt Lake City, Utah, April 12–15, 1959

RECORDED AND REPORTED BY A. F. GEIB

A meeting of the Board of Directors of the American Mosquito Control Association was convened at the Hotel Utah, Salt Lake City, Utah, 10:30 a.m., April 12, 1959, by Association President Commander John M. Hirst. Present were John M. Hirst, President; Archie Hess, President-elect; D. M. Jobbins, Vice President; T. G. Raley, Executive Secretary; L. W. Smith, Treasurer; A. F. Geib, Recording Secretary; Robert L. Vannote, National Advisor; Regional Directors—W. E. Bickley, S. E. Central; Vernon Conant, N. Atlantic; C. F. Scheel, N. E. Central; C. Donald Grant, S. Pacific; Osmond P. Breland, S. W. Central; Jay E. Graham, N. W. Central.

Absent were: Regional Directors—J. A. Mulrennan, S. Atlantic; Laverne S. Miller, N. Pacific; Dr. B. Hocking, Canada; and Dr. Louis Vargas, Mexico, Central and South America.

Others Present: Committeemen and others from time to time—Don Collins, Harry Stage, Bruce Brockway, Francis Creadon, T. A. Schoenfeld, Don Rees, Ernestine Thurman, Dick Peters, Howard Greenfield, Glen Collett, Thomas Mulhern, Chet Robinson, Russell Gies, Geo. McDougall and James A. Nelson.

It was moved by Hess that the minutes of the 14th Annual Meeting of the AMCA be approved as published in the June 1958 issue of *Mosquito News;* seconded by Jobbins; carried.

Mr. Schoenfeld, Director of the Salt Lake City Mosquito Abatement District, presented AMCA President John Hirst with a suitably inscribed gavel, a gift to the AMCA from the Salt Lake City M.A.D. On behalf of the AMCA, President Hirst thanked the Salt Lake City District for this most appropriate gift.

President Hirst appointed the following to the Resolutions Committee: Glen Collett, Chairman; Howard Greenfield, Dr. A. J. Rogers, Geo. R. Hayes and Patrick Nakagawa, Members.

Report of the President: Attachment #1.

Report of the Nominating Committee. Submitted by Chairman Lindquist. Attachment #2.

Report on the Association financial affairs and audit of accounts, by Treasurer L. W. Smith. Attachment #3.

Report from Committee on Finance, Charles F. Scheel, Chairman. Attachment #4.

Scheel submitted proposed budget for 1959 and moved its adoption; seconded by Conant; carried. Attachment #5.

Report from Editor of *Mosquito News,* Don Collins. Attachment #6.

Grant moved acceptance of report; seconded by Conant; carried.

Report of Program Committee, Hess, Chairman. Attachment #7. Program was developed from questionnaires sent early in the year. Operational subjects were emphasized. Jobbins moved acceptance of report; seconded by Grant; carried.

Hess reported that a balance of $49.59 remained from the $100.00 allotted to develop program. From this balance he requested approval to use $23.90 to pay for an AMCA speaker's podium which he had had constructed. In turn, he offered to contribute an additional $10.00 to the Good Neighbor Club. Raley moved approval; seconded by Scheel; carried.

Report on Local Arrangements not presented at this business session, as Chairman Glen Collett was absent.

Report of Committee on Sales of Advertising Space by Francis Creadon, Chairman. Attachment #8.

Mr. Creadon commented upon the importance of *Mosquito News* issues being published on time because of advertisers'

interests. He also urged everyone to submit to him names of potential advertisers. Bickley moved acceptance of report and commendation for a job so well done; seconded by Jobbins; carried.

President Hirst reported there was a good prospect of organized control activities developing at a rapid pace in the 50th State, Hawaii. There seemed to be a good potential for advertising here. He would submit a list of prospects to Mr. Creadon at an early date.

Meeting recessed at 12 noon, to reconvene 1:15 p.m.

Meeting reconvened at 1:30 p.m.

Report from Committee on Good Neighbor Club, Ernestine Thurman, Chairman. Attachment #9. Hess moved acceptance of report; seconded by Grant; carried.

Report from Committee on Miscellaneous Publications, Howard Greenfield, Chairman. Attachment #10.

Reported that the Committee had been working on Bulletin #4, and real progress made. All previous work has been reviewed and consolidated except one chapter. It should be available shortly for review by the full committee and then by the Board. Jobbins moved acceptance of report; seconded by Conant; carried.

Report from Committee on Sale of Miscellaneous Publications, Jay Graham, Chairman. Attachment #11. Raley moved acceptance of report; seconded by Lindquist; carried.

Report from Committee on Miscellaneous Publications, Chairman Chris Williamson absent. Attachment #12. Report read by Raley. Raley moved acceptance of report; seconded by Hess; carried.

Report from committee on Membership, P. Bruce Brockway, Jr., Chairman. Attachment #13. Scheel moved acceptance of report; seconded by Jobbins; carried.

President Hirst introduced James A. Nelson, Editor of *Pest Control,* attending full sessions of AMCA meetings.

Report from the Committee on Public Relations, R. E. Dorer, Chairman, absent. Attachment #14. Reviewed by Committeeman Grant. Bickley moved acceptance of report; seconded by Jobbins; carried.

Bickley read a letter received from Senator Hubert H. Humphrey, U. S. Senate; Chairman Sub-committee on Reorganization and International Organizations. Senator Humphrey's letter requested information on AMCA activities in the field of international health and research leading to improved health conditions throughout the world. President Hirst requested AMCA National Advisor and Chairman of Public Relations Committee to reply to Senator Humphrey, outlining activities of AMCA as related to international health. Bickley's personal reply to Senator Humphrey is presented as attachment 14a.

Report from Committee on Research and Development, William C. McDuffie, Chairman, absent. Attachment #15. Submitted by Lindquist. Lindquist moved acceptance, seconded by Bickley; carried. Lindquist questioned need for continuing committee, its activities, and reporting each year. No action.

Report from Historical Committee, Chairman Harold Gray, absent. Committeeman Mulhern reported review almost completed. Will be ready in a few days and available for publication in *Mosquito News.* No action.

Report from Committee on Bylaws, Chairman Bailey Pepper, absent. Attachment #16. Report presented by Raley. Bickley moved acceptance of report; seconded by Geib; carried.

Report from Committee on Legislation, Chairman John Mulrennan, absent. Report read by Raley. Attachment #17. No action necessary.

Report from National Advisor, R. L. Vannote, Attachment #18. Jobbins moved acceptance of report; seconded by Geib; carried.

Bickley moved that the President appoint an AMCA representative to the proposed coordinating Committee for Wildlife and Mosquito Control; seconded by Scheel. Motion withdrawn.

Appointment of this Committeeman and Representative to Minneapolis Metropoli-

tan Area withheld for designation by incoming President. President directed Vannote and Collins meet to consider potential of Ford Foundation sponsorship of AMCA projects.

Report of Ways and Means Committee by Dick Peters, Chairman. Raley moved acceptance of report; seconded by Hess; carried. Peters noted that committee had received no instructions and functioned as an exploratory rather than action group. The committee had solicited opinions from members of the Association, which were abstracted or quoted verbatim in 12 pages of typed manuscript. In view of its length the report was not read in its entirety.

Report from the Executive Secretary, T. G. Raley. Highlights on the activities of the Executive Secretary and Board actions during the year.

1. Board action by mail on new members and appointments.

2. Association insignia pins available to members.

3. Second class mail privileges approved for distribution of *Mosquito News*—should result in some savings to AMCA. At present there are 455 foreign accounts.

4. Recommended that the Association develop and provide the Secretary with an Official Seal. President Hirst appointed Conant to investigate and determine what type of seal would be most suitable.

5. Reiterated need for back issues of *Mosquito News*. Please send Executive Secretary all extra copies. Particularly in need of copies of joint AMCA and Virginia Association meetings held at Virginia Beach in 1950.

6. Suggested the use of a mail ballot procedure for membership committee when soliciting new members.

7. Encourages Ways and Means Committee to be continued.

8. Intends to compile a new list of all mosquito control agencies. Would like to have data concerning any new agencies formed in the past two years.

9. Association has 7 honorary members —25 exchange accounts.

10. Suggests the possibility of rotating the office of Executive Secretary so that others might be able to serve in this capacity.

President Hirst expressed thanks to everyone for all the help given in support of the Association, with special commendation for Raley, Executive Secretary.

Old Business—none.

New Business.

Report on invitations to hold 1960, 61 and 62 Annual Meetings of the AMCA.

Dr. Breland extended an invitation from the Gulf Coast Association to hold its next (1960) Annual Meeting at Galveston, Texas.

Executive Secretary read letter of invitation from the Northeastern Association, inviting the AMCA to hold its 1960 meeting in Boston, Massachusetts.

Executive Secretary read a wire from the California Mosquito Control Association inviting the AMCA to hold its 1961 meeting at Disneyland, California, or its 1962 meeting in the San Francisco Bay region.

Mr. Rapp, Nebraska, personally extended an invitation for the AMCA to hold its next (1960) meeting at Lincoln, Nebraska. He noted that there is no formal mosquito control association or agencies in Nebraska, but there is an interested group at Lincoln, willing to underwrite the AMCA meeting.

Decision to determine site of the 1960 Annual AMCA Meeting is left to the jurisdiction of the incoming board. No action taken.

Meeting adjourned at 4:05 p.m.

GENERAL BUSINESS MEETING—AMERICAN MOSQUITO CONTROL ASSOCIATION

Tuesday, April 14, 1959; 4:50 p.m.

Meeting called to order by President Hirst. Following activities reviewed and actions taken:

1. *Mosquito News* Editor, Collins, reviewed report submitted earlier (Attachment #6). He praised and commended the work of Associate Editors Mrs. Durkee, Miss Sollers, Dr. McDuffie and Austin Morrill, and Advertising Manager Francis

Creadon. He requested an increased number of operational and scientific reports to better represent these fields, for *Mosquito News*.

2. Local Arrangements Committee Chairman, Glen Collett, reported 296 registrations for this conference.

3. President Hirst called attention to and commended the Ways and Means Committee for an outstanding job. He suggested their work be a guide for future AMCA activities.

4. Report from Miscellaneous Publications Committee, Howard Greenfield, Chairman. Attachment #10.

5. Treasurer's Report, Lester Smith. Attachment #3. Explained value of and need for Assistant Treasurer.

6. Report from Resolutions Committee, Glen Collett, Chairman. Attachment #19.

7. Report from Committee of Good Neighbor Club, Ernestine Thurman, Chairman. Attachment #9.

8. Report from Bylaws Committee, Bailey Pepper, Chairman. Attachment #16.

9. Nominating Committee, Chairman Lindquist, presented following slate in nomination for AMCA officers for 1959. Attachment #2.

R. E. Bellamy moved the nominations be closed; seconded by D. J. Schliesmann; carried. President Hirst entertained a motion that a unanimous vote be cast in favor of the officers submitted by the Nominating Committee. It was so moved by Gardner McFarland; seconded by D. J. Schliesmann; carried.

10. Executive Secretary Report, T. G. Raley.

a. Noted that approval had been granted for distribution of *Mosquito News* as second class mail.

b. Noted that during the year action of the Board by mail ballot had seated Osmond P. Breland as Director from the S.W. Central Region, replacing Don Micks, resigned; approved Bruce Brockway, Jr. as Chairman, Membership Committee, replacing Don Johnson, resigned; increased the budget for *Mosquito News* by $800.00; approved travel expense for Association Officers as follows: Advertising Manager, $100, Executive Secretary, $100, Treasurer, $150, Editor, $150, and accepted all new members joining this past year.

Raley moved acceptance of these Board actions during the year; seconded by Hess; carried.

c. Requested extra or unwanted back issues of *Mosquito News* be mailed to the office of the Executive Secretary.

11. President Hirst extended a warm welcome for everyone to visit Hawaii. Anyone having the opportunity to do so, please look up either him or Pat Nakagawa for some true Hawaiian hospitality. He thanked all for their wonderful and helpful cooperation during his term of office and expressed appreciation for being able to serve as President of the Association.

Meeting adjourned at 5:30 p.m.

MINUTES—BUSINESS MEETING—BOARD OF DIRECTORS—AMCA, 5 p.m., April 15, 1959, Salt Lake City, Utah

Present: Hess, Raley, Jobbins, Vannote, Smith, Conant, Lindquist, Geib, Breland, Brockway, Collins, Bickley, Durkee, Graham, Hirst, Rees, Dorer, Rapp, Creadon and Mulhern.

Absent: Scheel, Mulrennan, Grant, Miller, Hocking and Vargas.

President Hess opened the meeting with discussion regarding new Program Committee. Breland moved Bickley be Chairman and Jobbins Vice Chairman; seconded by Conant; carried.

Jobbins moved Hirst be Chairman of the Nominating Committee, and submit list of members of Committee to Board of Directors by mail for consideration and approval; seconded by Breland; carried.

Hirst moved that the report of the Nominating Committee (a list of the nominees) be published in the *Mosquito News* issue prior to the Annual Meeting; seconded by Breland; carried.

Discussion was held concerning objec-

tives and functions of standing Committee on Publication of *Mosquito News*. Hirst suggested that the membership of this committee be presented to the Board of Directors for review and their approval before appointment. Concurrence with no action.

Discussion held regarding need for continuance of Legislative Committee. Agreed there might be need of action of committee on legislative matters, even though there appeared to be no legislative problems at present. Hess to consider membership of this committee.

Discussion concerning need for continuing Standing Committee on Research and Development. Hirst praised this year's committee report, McDuffie, Chairman. Attachment #15. Recommended composition of Committee be modified slightly to include an operational and commercial representative in addition to having a person as chairman with wide-spread international contacts, such as Tony Brown. No action.

Consideration of Committee on Finance. Hess opinion and general consensus that it was most important that Mr. Scheel continue as Chairman. No action.

Consideration of Special Committee on Sale of Miscellaneous Publications. Committee Chairman Jay Graham recommended the Committee be discontinued until such time as it might again be needed. No committee to be appointed this year.

Discussion concerning Committee on Miscellaneous Publications. Recommended to continue existing Committee until Bulletin #4 is completed.

Consideration of Bylaws Committee. Hess proposed Dick Peters as Chairman with new members for coming year.

Discussion concerning Public Relations Committee. No action.

Consideration of Committee on Membership. Bruce Brockway accepted appointment as Chairman, with Pat Nakagawa as assistant, requested suggestions for membership.

Discussion regarding Committee on Advertising Space. Creadon reappointed Chairman and will submit list of potential Committeemen to Hess.

President Hess asked that the Board Members study his proposal, "The AMCA broaden the base and scope of its interest to cover all vector problems and activities," and requested written opinions at an early date from members regarding such a possibility.

Discussion regarding Historical Committee. Requested that the Committee on Publication of *Mosquito News* review the completed history of the Association before its publication. Historical Committee to be discontinued.

Discussion concerning Ways and Means Committee. It was suggested that the Committee name be changed to President's Advisory Committee, with all Past Presidents as members. No action.

Consideration of Good Neighbor Committee. Ernestine Thurman reappointed Chairman.

Discussion concerning Editor, Associates and Staff for *Mosquito News*.

Lester Smith suggested that his office or Scheel's office be notified, not later than January, what miscellaneous expenses will be needed by Thurman, Durkee, etc.

The Chair entertained a motion that Don Collins and his Staff be reappointed. It was so moved by Hirst; seconded by Smith; carried.

Don Collins commended McDuffie on his work in reviewing technical papers presented for publication in *Mosquito News*.

Don Collins inquired about authority of his office to edit papers submitted for publication in *Mosquito News*. Bickley moved that the Editor of *Mosquito News* be instructed to condense at his discretion, with the aid of the Standing Committee on Publication of *Mosquito News,* and approval of the author, any material presented for publication in *Mosquito News;* seconded by Raley; carried.

President Hess reappointed R. L. Vannote National Advisor; unanimously approved. Hess commended Vannote highly for developing the Wildlife Conference recently held in Washington, D. C.

Vannote suggested that the AMCA, under the National Director's guidance, might like to sponsor an annual wildlife meeting in cooperation with interested agencies and groups and possibly include field trips. He reported that such a field trip along with local meetings, has been tentatively scheduled for the Minneapolis area in early October, under National Advisor sponsorship. He was instructed to develop a plan for such meetings and submit to the Board for later consideration.

Discussion held concerning office of Treasurer and Assistant Treasurer. The Chair entertained a motion to reappoint Mr. Thom, of Lester Smith's office, as Assistant Treasurer. It was so moved by Jobbins; seconded by Hirst; carried.

The Executive Secretary suggested that the President write a letter of commendation to Walter Henderson for his handling of the AMCA library the past several years. Unanimous approval.

Discussion concerning publication of the Proceedings of the 15th Annual Meeting of the AMCA. Jay Graham moved the publication be a joint proceedings of the AMCA and the UMCA in the June and September issues of *Mosquito News* and contain suitable acknowledgment; seconded by Conant; carried.

Consideration of location for 1960: 16th Annual Meetings of AMCA.

Breland extended an invitation from the Gulf Coast Mosquito Control Association to the AMCA to hold either its 1960, 1961, or 1962 Annual Meetings at Galveston, Texas.

Bill Rapp extended an invitation for the AMCA to hold its 1960 Annual Meetings at Lincoln, Nebraska. He noted that adequate facilities and financing would be made available under the Health Department auspices.

Invitation was again reviewed from the Northeastern Mosquito Control Association to hold the 1960 AMCA Meetings at Boston, Mass.

Discussion followed concerning the merit and advisability of setting dates and locations, at least tentatively, for 3 years in advance.

The Chair entertained a motion that the next Annual Meeting of the AMCA, 1960, be held at Boston, Mass. Hirst so moved; seconded by Bickley; carried.

The Chair entertained motions that this Board recommend to following Boards that the 1961 Annual AMCA Meetings be held in Southern California, the 1962 meetings in Galveston, Texas, and the 1963 Meetings, in New Jersey. These motions were seconded and carried.

The Executive Secretary was instructed to correspond with the Northeastern Mosquito Control Association to establish a meeting date for the 1960 Meetings, sometime during late March or early April.

Bickley moved that travel funds be authorized to certain Association Officers to attend the 1960 Meetings as follows: Executive Secretary $200; Treasurer $100; Advertising Manager, $100; Editor, $100; seconded by Breland; carried.

Consideration of AMCA representative for proposed Wildlife Committee. Bickley moved that Vannote be the AMCA representative for the proposed committee; seconded by Jobbins; carried.

Hess requested consideration of appointment of Board member from the Southeast Central Region to succeed W. E. Bickley, newly voted Vice President of the AMCA. Hirst moved appointment of Col. Bunn as Board Member from the Southeast Central Region; seconded by Breland; carried.

Breland recommended that the new Program Chairman give consideration to:

1. Fewer technical papers for next program.
2. Trustees have separate meeting room to discuss problems of mutual interest.
3. Group meetings be held concurrently covering different subjects.

Meetings adjourned 7:40 p.m.

ATTACHMENT #1

REPORT OF THE PRESIDENT

The files of the President became richer by more than 1200 letters which were answered by more than 1600 letters during the last 14 months.

Items of business transacted each month since the last meeting were reviewed. These included the following:

In May 1958, P. Bruce Brockway, Jr. and Patrick Nakagawa were appointed as co-chairmen of the Membership Committee, to replace Don Johnson who had resigned because of other duties and commitments.

In June 1958 Dr. Don Micks resigned as director of the Southwest Central Region, and Dr. Osmond P. Breland was appointed to fill out his term.

In July 1958, the treasurer received a check for $1,678.37 from Dr. W. E. Bickley—all the assets from the 14th annual meeting in Washington. Net to AMCA was $1,527.37. Congratulations, Bickley, Dorer, and their associates.

In August 1958, after considerable written discussion the Board of Directors was asked to increase the budget of *Mosquito News* by $800.00. Increased printing costs, increased number of copies printed, increased postage charges, made this upward revision necessary. This increase was approved in October.

Also in August, the president sent 120 letters to various members to ask for suggestions and criticisms, especially concerning raising funds, reducing costs, election of officers, etc.

In January 1959, the Board approved the use of travel funds as follows: $100.00 for Advertising Manager; $150 for Editor; $150.00 for Treasurer; $100.00 for Executive Secretary.

Much other routine business was transacted, most of it evident in the reports of committees which form attachments to the minutes.

The level of success attained by the American Mosquito Control Association, Inc., in the last 15 months will be judged by these committee reports. I am very proud to have had this opportunity to serve as President. I am deeply indebted to those who groomed me for this high office. I sincerely appreciate all those members who served me so faithfully; and, I am most happy that the United States Navy has allowed me the valuable experience, for to serve you as your President has made it possible for me to serve better in my assigned duties. My family and my friends made sacrifices and gave me confidence in my decisions. To all these and to all of you I am most grateful.

—John M. Hirst

ATTACHMENT #2

Report of Nominating Committee, 1959

The Nominating Committee was appointed by the President and the Board of Directors on February 26, 1958 at the annual AMCA meeting in Washington, D. C. Following the usual procedure the Committee was canvassed by mail for suggestions relative to national officers and regional directors for 1959.

After suggestions were received ballots were sent to the Committee members who voted unanimously for the following slate:

President, A. D. Hess
President-Elect, D. Manley Jobbins
Vice-President, William E. Bickley
Executive Secretary (2 yrs.), T. G. Raley
Treasurer (2 yrs.), Lester W. Smith

Regional Directors:

North Atlantic—Vernon Conant
Southeast Central—Wm. E. Bickley
Northeast Central—Chas. F. Scheel
South Pacific—C. Donald Grant
Canada—B. Hocking

Respectfully submitted,

A. W. Lindquist
Chairman

Committee members:

Edmund J. Stansfield
C. T. Williamson
William W. Warner
W. J. Buchanan
Glen C. Collett
Paul R. Meyer
Gaines W. Eddy
G. Edwin Washburn
H. P. S. Gillette

ATTACHMENT #3

AMERICAN MOSQUITO CONTROL ASSOCIATION
METUCHEN, NEW JERSEY

SUMMARY OF CASH RECEIPTS AND DISBURSEMENTS
Treasurer's Account, January 1, 1958 to November 26, 1958

RECEIPTS	General Account		Special Publications
Balance on deposit—January 1, 1958		$ 6,347.76	$ 1,927.30
Dues and subscriptions	$ 5,904.25		
Advertising	2,348.57		
Back issues	70.00		
Reprints	1,377.69		
Good Neighbor Club	530.00		
Bulletins	55.50		
Mailing lists	33.89		
Exhibits Committee—14th Annual Meeting	1,678.37	11,998.27	
		18,346.03	1,927.30
DISBURSEMENTS			
Printing of Mosquito News, reprints and mailing charges	10,951.35		
Office supplies, expenses, etc.	372.39		
Postage	181.93		
Fidelity bond	5.00		
Traveling expenses	500.00		
Purchase of emblems	192.50		
Examination of Treasurer's records	75.00		
Refund to subscriber	3.75		
Bank charges	3.34		
Checks returned	26.75	12,312.01	0
Balance—November 26, 1958 (on deposit—Commonwealth Bank of Metuchen, Metuchen, New Jersey)		$ 6,034.02	$ 1,927.30

ATTACHMENT #4

REPORT OF STANDING COMMITTEE ON FINANCE

The basic function of the Standing Committee on Finance is that of giving thought to the development of practical methods which may assist in returning additional revenue to the association. Further, in its 1958 report at Washington, D. C., the committee emphasized an equally important, if not more fundamental, role in its responsibilities—that of considering measures which might lead to further development and growth.

It is presumed, as mentioned in an earlier report, that we are a dedicated group with a special interest in all phases of mosquito biology and control, and must recognize that we are performing a highly important public service. The influence of an organization such as the AMCA could easily determine the value or effectiveness of this service by the part it plays in encouraging research and fostering sound techniques of control.

To do this requires skill, talent, perseverance and, last but not least, financial means.

The Finance Committee, in its 1958

report, offered a number of suggestions in these general categories. This committee desires that it be kept informed of any action resulting from its recommendations, so that it can take further further steps to improve its functioning. (Additional copies of the 1958 report may be had on request).

Respectfully submitted,
Robert L. Armstrong
J. Ray Barron
Eugene J. Gerberg
G. Edwin Washburn
Charles F. Scheel, *Chairman*

ATTACHMENT #5

Proposed Budget—1959

RECEIPTS

	Actual—1958	Estimated—1959
Dues and Subscriptions	$ 5,904.25	$ 6,350.00
Advertising	2,348.57	2,350.00
Reprints	1,377.69	1,000.00
Sale of Bulletins and Back Issues	125.50	100.00
Exhibits, Commercial and Contributions	1,678.37	1,400.00
Good Neighbor Club	530.00	500.00
Mailing List	33.89	0.00
	$11,998.27	$11,700.00

EXPENDITURES

Mosquito News (4 Issues)	$ 9,768.88	$ 9,500.00
Reprints and Miscellaneous Printing	1,142.47	1,000.00
Office Supplies	372.39	372.39
Postage	181.93	181.93
Fidelity Bond	5.00	5.00
Traveling Expense	500.00	500.00
Emblems	192.50	0.00
Audit	75.00	75.00
Refund to Subscribers	3.75	
Bank Charges	3.34	50.00
Returned Checks	26.75	
	$12,312.01	$11,684.32

ATTACHMENT #7

Report of Program Committee, American Mosquito Control Association

The program for the annual meetings of the American Mosquito Control Association held in Salt Lake City, April 13–15, 1959, was developed from comments and suggestions received in reply to a questionnaire mailed to 205 members of the Association. A second questionnaire was sent to 162 mosquito abatement agencies throughout the United States to obtain topics for discussion at an informal "operations clinic." An attempt was made to develop a program which would be of interest to operational and commercial as well as technical members of the Association. To accomplish this, maximum use was made of invitational speakers and informal discussion periods. Routine sessions of submitted papers were kept to a minimum.

A special effort was also made to have the program printed and mailed out to all members of the Association at least two weeks before the time of the meetings.

There follows a brief financial statement of the Program Committee:

RECEIPTS

1. Check from Lester W. Smith 1–23–59	$100.00

EXPENDITURES

1. Postage for questionnaire No. 1	$ 8.20	
2. Postage and envelopes questionnaire No. 2	11.10	
3. Postage remainder of year	24.37	
Total for postage and stationery	$43.67	
Telephone calls	6.74	
4. Speaker's podium	23.90	
Total expenditures	$74.31	74.31
Balance on Hand		$ 25.69

A. D. Hess

ATTACHMENT #6

EDITOR'S REPORT

Report on Volume 18, *Mosquito News*

Issue	No. Printed		No. Pages		Cost	
	Vol. 17	Vol. 18	Vol. 17	Vol. 18	Vol. 17	Vol. 18
March	1450	1650	84*	68*	$1917.26	$1774.43
June	1450	1650	88	152	1846.69	3278.85
September	1450	1650	116	104	2331.26	2260.16
December	1500	1650	120	92	2454.44	2301.91
Totals	5850	6600	408	416	$8549.65	$9615.35
Payments by authors and/or agencies for extra pages and complete articles						—461.80
						$9153.55

* Includes Index

	No. Pages	
	Vol. 17	Vol. 18
Proceedings	131	103½
Articles	115	144½
Oper. and Scie. Notes	4	5½
Editorial	3	1½
Association News	24	29½
News and Notes	15	17
Reviews and Abstracts	6	6
Bibliography	31	34½
Advertising	75	68
Miscellaneous	4	6
Total	408	416

Statistics for volumes 18 and 17 of *Mosquito News* are presented herewith. From these, interested readers can make various comparisons. Attention is called to points of special interest relative to costs. The cost per copy of both volumes 17 and 18 was about $1.46. If each copy costs $1.46, and we print 1650 copies of each issue as we did last year, the budget will have to be about $9,600.00 in 1959–60. Mailing cost will be less, since we now mail under second class privileges. The March 1959 issue was the first to be mailed under this arrangement.

DONALD L. COLLINS, *Editor*

ATTACHMENT #10

REPORT OF MISCELLANEOUS PUBLICATIONS COMMITTEE

The principal task assigned to this Committee was to evaluate and ready for publication Bulletin No. 4 which is titled, "Organization for Mosquito Control." Accordingly, the Committee reorganized the Bulletin extensively, but made little or no changes in the content or scope.

After reviewing the work done during the year, the Committee determined that Bulletin 4 should be sent to one individual for editing prior to printing. Harold Farnsworth Gray was recommended for this honor. The Committee contacted Mr. Gray who kindly consented to accept the responsibility.

The Committee also stated that they would continue to assist Mr. Gray in any way possible in preparing Bulletin 4 for publication.

Respectfully submitted,
HOWARD R. GREENFIELD, *Chairman*
THOMAS MULHERN
C. DONALD GRANT
FRANKLIN C. WRAY

ATTACHMENT #9

REPORT OF COMMITTEE, GOOD NEIGHBOR CLUB

During 1958–1959 there were 127 names on the list of Good Neighbors, an increase of 3 over the previous year. Ten elected to pay own dues; 4 canceled. There were 92 paid subscriptions, 16 of them new. Twenty-one Good Neighbors are as yet unsponsored. Thus, there are 113 Good Neighbors for 1959 to date.

During last year there were 58 Sponsors. Currently there are 51 Sponsors, 10 of whom are new, including 9 companies (4 new); 15 MAD and MEC (new); 27 individuals (4 new).

The financial status is as follows:

Operating Fund			
Balance Forwarded, 6/5/58	$126.73		
Receipts	465.00		
	$591.73	$591.73	
Expenditures			
Letterheads	$ 15.50		
Typist	50.00		
Postage	23.27		
	$ 88.77	$ 88.77	
		$502.96	$502.96
Check to AMCA, 4/9/59	$445.00		$445.00
Balance in Bank			$ 57.96
Paid directly to AMCA	$ 15.00		

ERNESTINE B. THURMAN,
Chairman

ATTACHMENT #12

REPORT OF COMMITTEE ON MISCELLANEOUS PUBLICATIONS

C. T. WILLIAMS, *Chairman*

GENERAL STATEMENT, December 31, 1958

Bulletin	Number of Copies Sold	Accounts Paid	Accounts Outstanding
1 & 2	1570	$3062.00	$ 65.50
3	870	1644.00	74.00

CHECKING ACCOUNT

Balance as of January 1, 1958	$548.11
Total deposits for the year 1958	+336.33
	$884.44
Total expenditures for the year 1958	—506.61*
Balance as of December 31, 1958	$377.83

* $6.61 Postage and $500.00 to the Association.

ATTACHMENT #8

REPORT OF THE COMMITTEE, GOOD NEIGHBOR CLUB

REPORT ON ADVERTISING IN *Mosquito News*, January 1, 1958 through December 31, 1958

The figures below represent transactions during the calendar year 1958, for advertising in four numbers, Volume 17, number 4 and Volume 18, numbers 1, 2 and 3. (December 1957 and March, June and September 1958).

Number of active accounts	30
Number of Pages of Advertising (exclusive of AMCA business)	68¼
Receipts	$2,477.14
Expenses:	
Postage, telephone, telegrams	62.50
Printing, rate sheets, envelopes, letterhead	30.00
Honorarium for stenographer	10.00
Total Expenses	$ 102.50

Respectfully submitted,
FRANCIS P. CREADON
Advertising Manager

ATTACHMENT #11

REPORT OF THE COMMITTEE ON SALES OF MISCELLANEOUS PUBLICATIONS

During 1958 the Committee on Sales of Miscellaneous Publications continued efforts to sell the special bulletins of the American Mosquito Control Association by inserting notices in appropriate publications, sending post cards to colleges and universities, and by personal contact.

The bulletins were well publicized by the officers and members of the Association before the committee was formed. These efforts and the efforts of the committee have sold enough bulletins so that the market appears close to saturation.

Continued efforts will still be made to sell bulletins but spectacular results should not be expected.

JAY E. GRAHAM
Chairman

ATTACHMENT #13

AMCA MEMBERSHIP REPORT

Your membership chairman is not responsible for the many additional memberships taken into the Association this year because he took the chairmanship at a point that might be considered half way through the AMCA fiscal year.

I would like to take this opportunity to compliment Don Johnson for his work as chairman of this committee until he resigned to take added duties overseas. Also, I want to thank Pat Nakagawa of Hawaii for his fine work this year on this committee. I know that he did more constructive membership campaigning than your chairman. I sincerely hope that he will be given the opportunity to be of even more assistance to the Association during this next year.

This year our new members just about balanced our delinquent members or those that are no longer associated with the AMCA. Our executive secretary, Ted Raley, brought to my attention that it is really a costly item to find out that an individual no longer desires to retain his membership in the Association. That problem has brought up two questions:

First, your membership chairman recommends a closer coordination between the executive secretary, the treasurer and the membership chairman. By that I mean that both the executive secretary and the treasurer have made great efforts to collect delinquent memberships and in many cases these efforts have not been rewarding. I personally feel that some of the responsibility for this action is up to the membership chairman and he should take steps to retain a membership. Perhaps a more personal approach would be respected and would be more to our advantage and the AMCA would be able to retain a membership instead of losing a more or less borderline case.

The second suggestion is that the membership chairman enlist the help of either the regional director or some other members of each of the regions of AMCA.

This step would give a closer coordination between the chairman and the members.

Respectfully submitted,
P. Bruce Brockway, Jr.
Chairman, Membership Committee

ATTACHMENT #14

Report of the Public Relations Committee, American Mosquito Control Association, 1958

The principal activity of the Public Relations Committee in 1958 was the building of a Mosquito Exhibit. The Committee Members were contacted for their ideas. After a plan for an exhibit was decided upon, construction was commenced. Several agencies throughout the country were asked to contribute suitable slides. All bills for material and service were paid by the Virginia Mosquito Control Association and later the American Mosquito Control Association reimbursed the Virginia Association. All labor with the exception of an artist to do the lettering was provided by Virginia members of the Association without charge. Special appreciation is due Messrs. McPherrin, Wisniewski, Hackworth and Jack Dent.

The exhibit cost $171.38 and there was an additional charge of $53.88 to ship it via express to Salt Lake City.

The exhibit is in the shape of a giant mosquito. On the head are included insets promoting *Mosquito News* and other American Mosquito Control Association publications. On the thorax there is a map of the world explaining that mosquito control is worldwide in scope. On the abdomen there are a set of transparencies showing different phases of control methods. The proboscis is a bubbling fluorescent light simulating the sucking of blood.

It packs into a box measuring 4′ wide, 8′ long and 10″ thick. It weighs 200 pounds. Complete instructions for setting it up are included. It could be carried in a large station wagon, but perhaps the best way to ship it would be by freight, giving plenty of time for delivery.

The following plan is proposed for assigning the exhibit: the Executive Secretary will be in charge of the exhibit. Anyone wishing to use it will contact him. The user will pay the freight to get it to him. He would be responsible for storing the exhibit and shipping it C.O.D. to the next user upon instructions from the Executive Secretary.

It is suggested that consideration be given to the development of a 4- to 6-page folder providing basic information and synopses of achievements aided or gained through the AMCA, together with an insertable fly page giving current data on membership, officers, functions and organizations of the Association. The basic folder could substitute for the membership sheet, or supplement it, and be printed in large numbers for up to five years and be used for general distribution at various meetings, exhibits, and agencies as well as by directors or others in soliciting membership. Such a brochure could utilize drawings, maps, *et cetera,* which would stimulate as well as inform, and the fly page could be printed annually at little cost for insertion where such information might aid in soliciting membership.

Respectfully submitted,
W. F. Rapp, Jr.
Harry D. Pratt
C. Donald Grant
Wm. J. Wall
J. S. Haeger
R. E. Dorer, *Chairman*

ATTACHMENT #14a

March 31, 1959

Honorable Hubert H. Humphrey
Chairman, Subcommittee on Reorganization and International Organizations
United States Senate
Washington 25, D. C.

My Dear Senator Humphrey:

Thank you very much for your letter of March 26 which you addressed to me

as Convention Chairman of the American Mosquito Control Association.

The annual meeting of the American Mosquito Control Association will be held in Salt Lake City beginning on April 12, 1959. Because of the short time before the meeting, I shall wait until then to bring the matters which you have mentioned to the attention of the Board of Directors. I am sure that action will be taken to furnish you with information about our activities in the fields of international health and research leading to improved health conditions throughout the world.

The two reports of your committee entitled "International Medical Research" and "The Status of World Health" are very interesting. It will be helpful if I can have three additional copies of these publications for the use of the Board of Directors at the meeting in Salt Lake City.

Your interest in our Association is deeply appreciated.

Sincerely yours,

WILLIAM E. BICKLEY
Head of Department and Regional Director, AMCA

ATTACHMENT #15

REPORT OF RESEARCH AND DEVELOPMENT COMMITTEE FOR 1958

Last year the Research and Development Committee assembled information on new developments in mosquito control by various research groups throughout the country. The Committee concluded from the information obtained that research was progressing satisfactorily and apparently fulfilling the need for more effective insecticides and methods of application. However, we learned later that many mosquito control workers did not share our enthusiasm and, in fact, felt that research had not provided answers to many pressing problems. This year, therefore, the Committee decided to ask the control workers to report on their problems and to suggest areas in which research was needed. In February a memorandum to this effect was drafted and sent to 150 supervisors and directors of mosquito districts in all sections of the country. The response to our inquiry was disappointing but, fortunately, the replies received contained many excellent suggestions. Also, the chairman recently had an opportunity to talk personally with a number of workers and obtained some additional suggestions on research needs. Brief discussions of these needs are given in this report.

CONTROL OF *Culex*. Most of the workers replying indicated that the control of *Culex* was their most difficult problem. Suggestions for research on these species are listed below:

1. Develop new designs for storm sewers which will eliminate *Culex* breeding.
2. Develop more effective insecticides or other methods for controlling or preventing *Culex* breeding in polluted waters, including ditches, sewage disposal and sludge areas, garbage and refuse dumps, industrial waste areas, and dairy drainage systems.
3. Determine why insecticides are much less effective against *Culex* in polluted situations. Find new insecticides that will be equally effective in all types of breeding sites.
4. Study the biology and ecology of *Culex* species, with special emphasis on biting habits. In this connection the question was asked, "Is it possible to direct control only against species attacking man or must control be directed against all species of *Culex*?"
5. Develop more effective larvicidal oils and insecticides.
6. Determine if frequent oil spraying creates more favorable conditions for *Culex* breeding by killing vegetation, thereby increasing organic matter in water.
7. Develop methods and materials that will provide longlasting control in storm sewers, thereby eliminating the necessity for weekly treatment.
8. Develop repellents that will discourage *Culex* oviposition in certain breeding areas and ovicides that will prevent hatching of eggs.

9. Study the possibilities of fish for *Culex* control in certain situations. Certain species might adapt themselves to unnatural environments and provide effective control.

Control of Floodwater Mosquitoes. Several workers indicated that floodwater *Aedes* and *Psorophora* species were their principal problem. There were several suggestions for research and pertinent questions regarding these species:

1. Study flight patterns and flight range of floodwater species. Information on these points might show that control efforts in outlying areas could be eliminated, thus effecting a considerable savings.
2. Determine the effects of prehatching applications of insecticides. Is effectiveness due to actual kill of larvae, destruction of food, depopulation, or other factors?
3. Develop more effective and longer lasting insecticides and formulations for prehatching treatment of floodwater breeding areas.
4. Develop insecticides that can be applied to breeding areas, i.e., materials that would destroy eggs and not create long-lasting residues or endanger fish or wildlife.
5. Can *vexans* and other floodwater species be eradicated in a given area? If so, what measures would be required to prevent reinfestation?

Irrigation Mosquito Problems. The Committee was disappointed in receiving only two replies from western States where serious mosquito problems have been created by irrigation. However, these letters contained several excellent suggestions for research. The Committee is taking the liberty of adding several to those submitted:

1. Study the biology of field and pasture breeding species of mosquitoes with a view of determining why they breed prolifically in certain situations and not in others.
2. Determine how field and pasture environments (soil and water conditions) might be altered so as to minimize oviposition and larval development.
3. Increase research to develop land and water management practices that will not create favorable conditions for mosquito breeding.
4. Develop insecticides that can be applied in irrigation water and that will provide season-long control.
5. Develop more effective residual insecticides for use as prehatching applications in fields and pastures.
6. Develop improved granular larvicides for use in fields and pastures.
7. Develop improved equipment for dispersal of granules, especially for aircraft.

Control of *Mansonia*. Although only one letter mentioned the problem of controlling *Mansonia,* at the recent New Jersey meetings several directors indicated that these species were a serious nuisance problem in their districts. At the present time the only solution to the problem is repeated fogging and spraying to control the adults. They indicated that drainage is not feasible and heavy applications of insecticides such as dieldrin are too hazardous for use in most breeding areas. However, it was felt that intensive research could in time provide safe and effective methods and materials for control of *Mansonia* breeding. Several possibilities for research were suggested:

1. Develop systemic insecticides which could be applied to vegetation to kill larvae.
2. Develop granular formulations that would release insecticide slowly in sufficient amounts to kill larvae but not harm fish or wildlife.
3. Investigate the possibilities of repellents or other materials to prevent oviposition.
4. Investigate the possibilities of ovicides.
5. Develop methods of managing impoundments to destroy breeding and/or to discourage oviposition.

RESISTANT MOSQUITOES. Practically every letter received contained some comment or suggestion on the problem of resistance in mosquitoes to insecticides. Most of the writers were already faced with resistance in one or more species; others expressed concern for the future if resistance developed in their districts. Suggestions and questions about resistance are listed below:

1. Determine the mode of action of the various insecticides used in mosquito control.
2. Determine the mechanism of resistance to various insecticides.
3. Develop ways and means of interfering with or nullifying specific resistance mechanisms.
4. Study the genetics of resistance in mosquitoes.
5. Develop entirely new types of insecticides and control techniques.
6. Determine the effectiveness of known insect pathogens on mosquitoes, especially the larvae. Search for specific disease organisms for mosquito control.
7. Is there any way to anticipate the development of resistance and to prevent or delay it by changing insecticides or operational methods?

EFFECT OF INSECTICIDES ON FISH AND WILDLIFE. Several workers indicated that Audubon and various fish and wildlife groups were exerting heavy pressure on local authorities to discontinue mosquito control. All of us connected with mosquito control are aware of the increasing criticism from these organizations. Those who are having to face such criticism feel that something needs to be done to offset it. Suggestions for work with this in mind were as follows:

1. Determine, in cooperation with wildlife biologists if possible, if the low dosages of the various insecticides used for larval and adult mosquito control are actually destructive of birds, fish and wildlife. Do repeated applications of low dosages have less harmful effects than the total amount applied at one time?
2. Determine, in cooperation with wildlife biologists, if possible, if insecticidal residues resulting from mosquito control operations poison the food of birds and other wildlife and if consumption of this food kills them or affects their reproduction.
3. Develop insecticides and methods of use that will not adversely affect fish and wildlife.

MISCELLANEOUS PROBLEMS. One district director suggested that a study be made of cost of insurance coverage. He pointed out that fairly complete coverage for his small organization cost $1,800 per year. This seems to be an excessive premium rate. Perhaps some members of the Association have solved this problem locally and can give expert advice on this matter. It would seem that insurance costs could best be investigated by State control organizations. However, the Association might wish to look into the matter.

Some of the suggestions for research listed under specific headings obviously apply across the board. For example, new insecticides, ovicides, fish, and water management are important in the control of all species. However, for the sake of brevity they have been listed only in connection with the problem referred to by the writer.

The Committee recognizes that research is being conducted on many if not most of the suggestions submitted by mosquito control workers. Excellent progress has been made along some lines and can be expected in due time on others. We would conclude therefore, that those suggesting research on these phases had in mind an intensification of research. The Committee subscribes to this idea, for increased effort means faster and greater progress in the solution of problems.

On the other hand, there are a number of suggestions which are not under active investigation and a number of questions that cannot be answered. A greater response to our inquiry would doubtless have extended the list considerably. However, the suggestions received are sufficient to convince all research groups of the need

for expanded work on mosquito biology and control. The Committee urges that the organizations engaged in research make every effort to undertake work on one or more of the suggestions.

Respectfully submitted,
W. C. McDuffie, *Chairman*
Kenneth D. Quarterman
Ralph W. Bunn
D. Manley Jobbins
M. W. Provost
Wm. R. Horsfall
Eugene J. Gerberg

ATTACHMENT #16

Report of the Bylaws Committee, Salt Lake City, Utah, April 12–19, 1959

At the 14th annual meeting, February 23–26, 1958, Washington, D. C., the Bylaws Committee made recommendations to the Board of Directors that were adopted at the final business meeting (*Mosq. News,* Vol. 18, #2, p. 149 and attachment #6, June 1958). The 1958 Bylaws Committee carried out the directive of the Board and canvassed the membership by mail to determine whether the members wish to continue the present procedure of electing officers or amend the bylaws to provide for the election of officers by mail ballot. (The present bylaws now provide for elections by mail ballot, Article VIII, Section 2). Accordingly, an appropriate statement of explanation was prepared along with a ballot form and mailed to each member of the association, asking the member to vote on this important issue. A ballot committee to tabulate the votes was appointed by the chairman. The vote was: Continue the present method of nominating and electing the officers of the association (votes for—present method 289, mail ballot 175).

Proposed amendments of minor importance were received by the committee. A majority of the members felt that these proposals were of such minor importance that it would be unwise to propose such amendments to the bylaws at this time.

Respectfully submitted,
Bylaws Committee, AMCA
K. R. Quarterman
C. M. Gjullin
Doyle Reed
R. L. Vannote
T. G. Raley
B. B. Pepper, *Chairman*

ATTACHMENT #17

Report of Legislative Committee

There has been only one item presented to the Legislative Committee—the subject of Federal Surplus Property being made available to mosquito control districts. In this connection, we can report that S. 3121 and H.R. 10010 bills were introduced in the 85th Congress 1958 to amend the Federal Property and Administrative Services Act of 1949 to authorize the disposal of certain surplus property to public health agencies of a State, its political subdivisions and instrumentalities.

This is the second attempt that has been made to amend the law to assist mosquito control districts. It is doubtful that the Department of Health, Education, and Welfare will allow the law to be amended even to take in small subdivisions of State Governments unless they are directly tied in with health centers, hospitals, schools and Civil Defense.

J. A. Mulrennan

ATTACHMENT #18

Report of National Advisor

The duties of the National Advisor may be classified as routine and special.

Routine duties have consisted of the correspondence and assistance to the officers and members of the Association through the year. Although this entailed

considerable time and expense, it is not only a pleasure but helpful to hear from the membership relative to their problems and accomplishments.

The special event of the year was the Symposium on the subject, "Mosquito Control and Wildlife Conservation," held in Washington, D. C. on April 1 and 2, 1959. This meeting was co-sponsored by the U. S. Fish and Wildlife Service, the U. S. Department of Agriculture, the U. S. Public Health Service and the Wildlife Society. The attendance was 82.

The prepared papers and the discussions presented an unusually large amount of valuable information. The proceedings are to be mimeographed and will be available at $1.00 per copy.

A resolution was adopted at the Symposium authorizing the appointment of a committee consisting of 6 members; 3 from wildlife interests, 3 representing mosquito control as follows: 1—USDA, 1—USPHS and 1—AMCA, for the purpose of considering methods of coordination between the two interests.

I am advised by the Ford Foundation that a Committee on Natural Science and Engineering has been established; however, its projects have been only with Engineering Graduate Schools. It was suggested that the Association present its project in June; however, no encouragement was received.

Plans are now being considered for a National Advisor's Field Trip to the Metropolitan Mosquito Control District in the Minneapolis-St. Paul area of Minnesota in early October of 1959.

Respectfully submitted,
ROBERT L. VANNOTE
National Advisor

ATTACHMENT #19

RESOLUTIONS COMMITTEE REPORT, 1959

RESOLUTION #1. RESOLVED:

That the American Mosquito Control Association expresses and records its appreciation and thanks:

a. To the Utah Mosquito Abatement Association, and particularly the local Arrangements Committee, for the excellent program and accommodations, which have made such a successful Fifteenth Annual Conference.

b. To the staff and management of the Hotel Utah for their friendly spirit and service.

c. To the Hon. George D. Clyde, Governor of the State of Utah, and his office staff, for their cooperation and response to the Association's needs.

d. To the Editor and Staff of *Mosquito News* for the efficient manner and splendid work done in the publication of the Association's Journal.

e. To the Salt Lake City Chamber of Commerce Convention Bureau for the fine cooperation accorded to the Association.

f. To the business people and other citizens of Salt Lake City for the fine moral, Christian attitude which has characterized their relationships with convention members.

g. To the Officers, Committees and National Advisor for the generous time given and the contributions made by them during the past year.

Be it Further RESOLVED:

That the Association express its thanks and appreciation to the commercial exhibitors and sponsors for their support of the American Mosquito Control Association.

RESOLUTION No. 2

WHEREAS one of the principal objectives of conventions is to present and exchange technical information for the mutual benefit of those in attendance, and

WHEREAS, the use of slides is one of the most effective and frequently used methods of presenting important data: RESOLVED, That this Convention go on record respectfully to urge that those using this method in future conventions make a special effort to prepare slides which can be

read clearly and easily from any position in the convention room.

Resolution No. 3

Whereas there has been a great amount of misinformation and misinterpretation published by well meaning people on the hazards of pesticides to man, animals, fish, birds and wildlife, in many instances with disregard to the enormous benefits resulting from the proper use of pesticides to control public health and agricultural insect enemies of mankind, and

Whereas the public, to a great extent, is unaware and therefore unappreciative that the preponderant majority of scientists and public officials engaged in research on the development and in the application of pesticides, is equally dedicated to the protection and preservation of the public health and well being and is accordingly deserving of the public trust, Resolved, That this Association go on record as urging its individual members to take all steps possible to present accurately to the public the excellent record of mosquito control in performing a public service characterized by sound technology, and that cooperation be extended, when indicated, to evaluate jointly any situations involving questionable pesticide usage affecting man, domestic animals and wild life.

Resolution No. 4

Whereas, research is one of the methods required for the coordination of mosquito control and wildlife conservation and

Whereas, it is the policy of the American Mosquito Control Association to promote such research in the interests of coordination, Resolved, That the American Mosquito Control Association endorse and support the principle of additional research pertaining to mosquito control and wildlife conservation as set forth in H.R. 5813 of the 86th Congress.

Resolution No. 5

Whereas, this 1959 meeting marks the 25th year of continuous service to mosquito control provided by the American Mosquito Control Association and its predecessors or society, The Eastern Association of Mosquito Control Workers, since the founding of the former in 1935, and

Whereas, the exchange of information promoted during this period by the Association has aided immeasurably in the advancement of new mosquito abatement procedures, and in the development of new and expanded mosquito control programs in areas of need throughout the world,

Resolved: That this quarter of a century of accomplishment be commemorated by spreading this resolution upon the minutes of this meeting, and by publishing in *Mosquito News* the history of the Association, which has been prepared by the Historical Committee.

Respectfully submitted,
Glen C. Collett, *Chairman*
Dr. A. J. Rogers
Patrick Nakagowa
Howard Greenfield

NEWS AND NOTES

AUSTIN W. MORRILL, JR.

WE ARE INDEBTED TO MR. ROLFE PETERSON THE INIMITABLE AND REFRESHING FUN-MASTER OF OUR AMCA BANQUET AT SALT LAKE CITY for an original poem which he recited for us. We wish we could get his droll tone of voice into our type, but even without it, this engaging bit of verse certainly merits a deathless place in our literature. It's entitled, simply,

The Mosquito

The mosquito is a funny bird,
It breeds in watery places.
Then when it hits maturity
For human flesh it races.

To golfers, gardeners, fishermen,
This bug will give their due . . .
Then when you slap and kill it,
It bleeds *your* blood on you.

It would be impossible to do justice, as many members asked us to do, in any tribute to Mr. Rolfe's masterful handling of the amenities of the banquet, or to the singing of the Edmunds Bros. barbershop quartet, or to the pleasant social hour provided by Willys, or to our old friend Mr. Schoenfeld and his many Utahn cohorts who once again demonstrated the unsurpassed ability of the people of that amazing state to give a gracious welcome and a memorable stay to their visitors. AMCA made a small gesture toward Mr. Schoenfeld by presenting him with a pair of mosquito emblem cufflinks as a token of the title bestowed on him by DON REES, "Mr. Mosquito Control" of Utah.

Then Utah, past master at the art of One-upmanship when it comes to courtesy and generosity, presented AMCA with a gavel of Utah walnut and copper, and beautiful hammered copper bowls to retiring Prexy MO HIRST, President ARCHIE HESS, Executive Sec. TED RALEY and our Banker, LESTER SMITH. BOB VANNOTE presented a scroll to Mo and there were short and pleasant speeches all round and Trustees and Board Members from Districts across the country were introduced, including OTTO MCFEELEY, who is very nearly "Mr. AMCA," we should imagine. The speeches ranged from a fine address by the Mayor to a small resumé of *just what happened* in that stuck elevator, when HELEN LOUISE DURKEE spent about forty minutes trapped between floors with the inestimable PETERS BROS., but fortunately for her "rep" (!) also MRS. BOB PETERS and Nine Perfect Gentlemen. We refrain from telling what *We* know except that from somewhere behind us (we couldn't turn) an Editorial sort of voice asked after about 30 minutes if anyone had noticed any signs directing one to the Men's Room.

MEANWHILE, BACK AT THE TYPEWRITER . . .

WE ARE THINKING OF OPENING A NEW SECTION ENTITLED "WHERE'S WHO" or "NOBODY EVER TELLS US ANYTHING." We are apparently always the Last to Know, so we hesitate to tell you things you heard way last winter, but nevertheless . . . here goes:

LEE HALL has left the San Joaquin Mosquito Abatement District, where he had been for the past four years, and has assumed the position of Manager and Entomologist for the newly-formed Fresno Westside Abatement District, the formation of which we noted last issue. His place as Entomologist and Assistant Manager of the San Joaquin MAD was taken by JIM MALLERS, who was previously entomologist for the Contra Costa MAD. *Ave atque vale* (or the other way 'round), LEE AND JIM.

HERB HERMS, moving even farther, has left California completely (How could he have done *that?*) to go to the South Cook County Mosquito Abatement District, Illinois, and they're getting a mightly fine man, though quiet. And ED WASHBURN is or is about to or is reported to be about to leave for Liberia, for ICA, any moment now. Wanderlust hit ED late but it shore took a bite when it got him. He's gone about as far as he could go, as the song says. GEORGE BURTON used to write us some mighty interesting things from there; it sounded real fine and we know ED will enjoy himself. Good luck!

HARRY STAGE has retired again (he swears) and will temporarily be located at Coos Bay, Oregon. He's just going to set and rock, he says. Sometimes he'll watch the waves and sometimes he'll fish, and then again he won't. Any bets on how long THIS retirement will last?

BOB DUCHANOIS retired, too, from the Navy, at least, and a sad loss it was for the Navy, too. But the Navy's loss is Florida's gain, because Bob hated to leave Jacksonville last year and as soon as he could, he hot-footed it back. He's now with the Bureau of Entomology, Florida State Board of Health, P. O. Box 210, Jacksonville, Florida. Congratulations, JOHNNY, on a fine acquisition.

JOHNNY MULRENNAN may have gained a man from the Navy but he has given (well, anyway, *lent*) one back . . . ENSIGN MULRENNAN, MSC, USNR. Welcome aboard!

DON PLETSCH, still with the Oficina Sanitaria Panamericana, Mexico 6, D.F., Mexico, has moved from his old address (Roma 36-B) to: Havre 30, Piso 3. Still, as we said above, in Mexico 6, D.F., or Mexico *City* to us outlanders. (Once, years ago, on a trip to Mexico, we learned that *Mexico,* as used by Mexicans, meant The City; the Country is Los Estados Unidos de Mexico).

Tommy Mulhern Went up to Oregon in March and Early April as the guest of CDC and the Oregon State Board of Health to instruct a training course on mosquito control, sponsored by the Oregon body. His course emphasized, needless to say, the importance of source reduction and gave practical information on how to go about it.

Meanwhile Gordon Smith, California Mosquito Control Association prexy, sent out an all points invitation for his demonstration and seminar on airplane applications of insecticides, held at Modesto on the 18th of May.

And Mo Hirst Brushed the Dust of Utah and the United States from His Navy Blues by taking off on another round-the-circuit swing through Okinawa, Formosa, the Philippines, Korea, Japan and Guam. Would we were a bird.

"Fred L. Soper, director of the Pan American Sanitary Bureau, Washington, D. C.," reports *Science* for 29 February 1959, "was honored upon his retirement on 1 February with the establishment of the Fred L. Soper Lectures in International Health. Bureau staff members will finance the lectures by donations to a special fund. The first lecture will be given this fall by Soper himself at Johns Hopkins University's School of Hygiene."

While We Are Name-Dropping, A Fellow Named Abraham Lincoln is Quoted in *The Army Reservist* for February as Saying, on the floor of Congress, "By the way, Mr. Speaker, do you know I am a military hero? In the days of the Blackhawk War I fought, bled, and came away. I had a good many bloody struggles with the mosquitoes, and although I never fainted from loss of blood, I can truly say I was often hungry." End of quote.

Bill Bickley Spotted a Dispatch from Rajkot Sent Out by *The Evening News of India* which should be a warning to us all. It says:

"Three lions have been visiting the Collector's bungalow constantly for the last three days. They killed two donkeys on Monday.

"A strong guard has been posted outside the bungalow.

"Two lions were seen within the compound of the Bahauddin College on Monday.

"Harassed by mosquitoes in the Gir forest, the lions have presumably sought refuge in the city."

The *New Yorker* magazine, which bulletined Bick on this, added the comment, "Where DDT makes things good for everybody except people who are about to get eaten by a lion."

The California Mosquito Control Association, the California State Department of Public Health and the University of California Are Jointly Sponsoring a Seminar on Management for Mosquito Control Administrators, to be held on 20 through 22 October, 1959, at Asilomar, Pacific Grove, California. The fee is $25.00, exclusive of housing and meals and the setting so Elysian that we have never known how conferences can get anyplace there. (In our youth the place was a YWCA camp. *We* were boots at the Presidio of Monterey. Now *there* was a proper sort of use for the place.) But back to the seminar. . . . The plans look mighty productive and the attendance is limited to 40. Don't crowd fellers! It's business!

The Armed Forces Pest Control Board Has Yielded to the Considerable Pressure Generated by the Glowing Reports of Those of Us Who Attended Last Year and announces the second presentation of a training course on military entomology, to be held during the period 3 to 14 August, 1959, at the National Naval Medical Center, Bethesda, Maryland. This splendid course on the specialty which is military entomology, is designed to provide advanced training for active duty, reserve and civilian entomologists of the three services; but it is also for individuals from universities and other civilian organizations, to whom it is intended to make known the contributions which the military services are making to the science of entomology and the control of pests and vectors, to present the problems which face the military (and thus to stimulate research on basic and applied problems) and to foster the continued sympathetic and cooperative assistance being given the military by universities and other civilian agencies. Attendance will be limited to 30 persons. Mosquito controllers who are Reserve Officers or civilian employees of the government are especially urged to take advantage of this course and others are also cordially invited. Inquiries should be addressed to The Executive Secretary, Armed Forces Pest Control Board, Forest Glen Section, Walter Reed Army Medical Center, Washington 12, D. C. (That's Col. Ralph Bunn, of course.)

George Burton, whom we mentioned earlier in connection with Liberia, writes from his TCA laboratory in Delhi, that he has put together some 275 8 x 10 photographs of Filariasis in all its aspects and is working on 4 color film strips to be used in training. He says that he attended the 3rd WHO malaria conference in Delhi and saw a number of AMCA'ers, including Don Johnson. So that's the sort of "work" that made Don give up his committee work! Trips to India! Hmmm.

Speaking of Far Climes . . . we have just received a copy of the Proceedings of the Tenth International Congress of Entomology, published in 1958, which contains a considerable and illuminating article by one Harry H. Stage on *Malaria-Control Problems in Vietnam*. On the first page it says in a footnote, (and we quote), "Retired Nov. 1, 1956." Again, if we may say so, Hmmm.

WE SAW VIRGIL MILES AWHILE BACK and he passed on some info about his new area which we thought you'd all be interested in. His new address is Toxicology Laboratory, P.O. Box 73, Wenatchee, Washington, and his principal area of study is the Columbia River Basin where some additional 60,000 acres are being developed for irrigation yearly. Portions of the Basin irrigated since 1952 are already showing high levels of transmission for both western and St. Louis viruses, as indicated by chicken serum surveys. Virgil says they plan to determine the antibody rates of sera from farm poultry raised each year, along with studies of mosquito populations and differing environments. (Many of the newer farms, for instance, have few buildings and no trees.) They'll also cover irrigated areas in Oregon, Idaho and Montana. Virgil reported that granular dieldrin was again effective in Montana last year, even at ¼ pound of toxicant per acre.

ERNESTINE THURMAN HAD A TABLE AT THE MEETINGS for those who are or want to be *or should be* members of the Good Neighbor Club. It had some very encouraging lists of Good Neighbors and gave us a solid idea of what a great lot of good the Club is doing for us and for others. Also at her booth were two new forms, *Application for Employment* and *Help Wanted*. These forms are a start toward a sort of clearing house to help our members find the man for the job.

ONE OF THE HIGHLIGHTS OF THE VIRGINIA MOSQUITO CONTROL ASSOCIATION'S HIGHLY LIGHTED MEETINGS on 24 February at Suffolk, was a talk by CHUCK GERHARDT of CDC. *Skeeter* commented, "Some mosquito control field men may think of Entomology as a 'dirty word' that is too technical to be understood by a layman . . . but no one is likely to forget his informal and down-to-earth treatment of this often misunderstood subject." Other notables programmed were CLYDE FEHN, BOB VANNOTE, JOHN FLUNO, ART LINDQUIST and CHARLIE WHITE.

FLASH! CHET ROBINSON FINDS NON-RESISTANT MOSQUITOES IN CALIFORNIA!! Chet reported recently that during one month his Alameda County (California) Mosquito Abatement District had "treated 4,500 tree holes with DDT," making a total of 22,936 tree holes treated during the winter season. So not all is gloomy in the resistance picture, after all. *Aedes sierrensis*, at least, is not yet able to withstand parathion, (we hope).

THREE FINE ANNUAL REPORTS HAVE BEEN RECEIVED FROM DISTRICTS WHICH ARE WIDELY SEPARATED, BUT UNITED IN EMPHASIZING SURVEY AND SOURCE REDUCTION. IN ORDER OF AGE, ST. LUCIE COUNTY (FLORIDA) SANITARY DISTRICT TAKES THE LEAD. This District, located at Ft. Pierce, made its 32nd annual report this year, and their analysis of the results of light trap and biting count surveys makes mighty interesting reading. Treading close upon their tale . . . as the mockturtle said . . . comes the DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT, of Lyons, Illinois, who present their 31st annual report. It, too, contains meaty analyses of breeding places, source reduction, and surveys. These annual reports contain so much, in fact, that we can't hope to summarize them and can only mention highlights such as that Desplaines caught some very rare species in their light traps: *Aedes sollicitans* (the third since 1928), *Aedes mitchellae*, *Aedes nigromaculis* (this is *rare*? what a heavenly place!), *Culex erraticus*, and 17 *Psorophora confinnis*. We know quite a few folks who'd like to have these species be rare where *they* are. The third Annual Report mentioned above, is that of San Mateo County (California), MAD, a relative newcomer. They kept some fine records, such as a breakdown on manhours spent on each type of activity and analyses of light trap catches. Of especial interest to Westerners is the report of their continuing studies on the biting black gnat, *Leptoconops torrens*.

THE FIRST SUBJECT FOR WHO'S WHO THIS TIME IS A MAN WHOM MANY AMCA'ers have known well for his fine work in several parts of the country although he is a relative newcomer to mosquito control. He is so unassuming and "natural" with everyone that we once walked into a hotel in Tokyo and found him sitting in the dining room and proceeded to talk to him for about five minutes, with only a casual hello to start with, before it suddenly dawned on us that we hadn't seen him for about five years instead of having just seen him yesterday! He hadn't changed a bit from when we knew him in Orlando, Florida, during the war, and what's more he didn't act a bit offended that we just started up a five-year-old conversation again without any fanfare. Well, maybe we'd better start at the beginning. He was born in 1913 in Warner, Oklahoma, and received his BS from Oklahoma State in 1938 and his MS in 1940 and then did some two more years' work at Iowa State College. He worked for the U. S. Department of Agriculture on lice and scabies control, at the famed Orlando Laboratory, and on U. S. Army assignments (that's how he happened to be in Tokyo, on his way back from Korea), and is now in charge of the laboratory on Insects Affecting Man and Animals, at Corvallis, Oregon. His name . . . GAINES EDDY. You guessed? Aw . . . .

CHARLES S. WILSON has been an AMCA member quite a bit longer and has worked on mosquitoes even longer yet, starting at the Beltsville, Md., research center in 1938. Before that he had been born, of course, in 1904 at Yakima, Washington, and graduated from the University of California in 1933. In 1935 he received his M.S. degree there also and did further graduate work in insect physiology for nearly three years. When the World War II broke out he left Beltsville for Bethesda and the Naval Medical Research Insti-

tute and later served with NAMRU #2 in the South Pacific. Something about that decided him to seek colder climes . . . or maybe it was the greater abundance of mosquitoes . . . but since then he's been in Alaska, where his address is Arctic Health Research Center, U. S. Public Health Service, Box 5, Anchorage. Drop in you tourists to our next-to-the-newest State.

T. A. SCHOENFELD, whom we mentioned in talking about the wonderful Utah meetings he has sponsored, is 77 years old and sets a high mark for youngsters in their fifties and sixties to shoot for, with his activity in city planning, and above all that part of it which has to do with mosquito control. After 50 years with the Crown Zellerback Co., Mr. Schoenfeld "retired" in 1951 and thereupon turned his full attention to the abovementioned activities. He has been a member of the Salt Lake Mosquito Board for nearly twenty years, twice as President, and has also been a prime mover in the organization and subsequent active member and president of the Utah Mosquito Control Association and one of the organizers of the Salt Lake City and County Mosquito Abatement Districts. He was chairman of arrangements for the AMCA meetings in 1952 and again was active, as we mentioned earlier, in the excellent arrangements this year. He has been always and indefatigably on hand to make us feel at home when we have attended the vigorous and stimulating meetings of the Utah Mosquito Control Association. A little known project of his was the National Peace Gardens in Salt Lake City and some years ago he received an accolade in the Salt Lake Tribune in a half page spread on his industry in improving the neglected West Side with parks and playgrounds until the area had been turned from a blighted one into one of the City's many assets. He's certainly been one of AMCA's major assets and we hope he continues in that role for a long time to come.

As we went to press the last lines of the editorial on page 104 were reviewed with extreme sadness. The proofs of Sam Minnich's paper were returned on June 6 by Mrs. Minnich with the brief note, "Mr. Minnich passed away very suddenly last Sunday . . ."

Sam was a most loyal member of AMCA, a vigorous and articulate advocate of everything that seemed to be good for the organization as a whole, and for its members individually. The editor, being trained more in the academic tradition, especially appreciated the wise counsel and friendly support of this very practical and down-to-earth man, and until a more fitting tribute can be written by one of his colleagues, wishes to express his sorrow at Sam's passing.

At this time, further, we have the sad duty to record the sudden death of another well-known AMCA member, who was also a frequent contributor to *Mosquito News*. Under date of June 12 we received the following letter from Gordon Smith:

"I'm sure that you and the readers of *Mosquito News* will be as shocked and saddened, as we were, to learn that Dr. Willis E. Snow died in London, England, at 4:30 a.m. today from heat prostration. He was a key member of our staff and was on his way back to TVA via Egypt and London after spending eight months at the East African Trypanosomiasis Research Laboratory, Entebbe, Uganda, on a Fulbright Scholarship. His wife, Rosemary Simpkins Snow, and 5-year old daughter, Laurie, were with him. His death is a great loss to Entomology and his multitude of friends."

It is expected that by the next issue of *Mosquito News* we will have more space and more information on Sam Minnich and Will Snow, together with tributes to Professor Matheson and Clell Wiscup, both of whom died during the past year.—D.L.C.

REVIEWS AND ABSTRACTS

HELEN LOUISE DURKEE

A FIELD GUIDE TO COMMON MOSQUITOES OF CALIFORNIA. By the Entomology Committee of the California Mosquito Control Association. Editor, Dr. E. C. Loomis, Bureau of Vector Control, Calif. State Dept. of Publ. Hlth. 1959. 30 pp. 80 figs. 1 chart. ($1.00 per copy. Address G. E. Washburn, Sec'y, C.M.C.A., P. O. Box 629, Turlock, Calif.) The Entomology Committee of the California Mosquito Control Association and the Bureau of Vector Control of the California State Department of Public Health have again produced a fine publication of value to mosquito workers everywhere. With Dr. E. C. Loomis as editor, a 30-page, plastic-bound brochure has been produced covering 25 of the 43 species of mosquitoes found in California, including those species which are important in the mosquito abatement districts.

The booklet contains keys to the females and larvae, short biological notes, a glossary of terms, and a tabulation by counties of the occurrence of all 43 California species. The keys are most unusual in having 3 or more line drawings interpolated between the couplets on each page. This procedure has made it possible to refer to each character in the couplets, usually without even turning a page. The characters have been well-chosen, and the line drawings by C. J. Stojanovich are among the best published in a mosquito book anywhere in the world. This reviewer has only one minor technical criticism; he would like to see a few dark scales on the tip of the palpus of *Anopheles franciscanus*, figure 23.

Mosquito control activities would be far easier and more effective if every area had a booklet with as workable keys, fine illustrations, and good biological notes on the important species.—Harry D. Pratt, Communicable Disease Center, U.S.P.H.S., Atlanta 23, Georgia.

ACTION OF REPELLENTS ON MOSQUITOES FEEDING THROUGH TREATED MEMBRANES OR ON TREATED BLOOD. Bar-Zeev, M. and Smith, C. N. J. Econ. Ent. 52(2):263–267. 25 refs. 1959. A method for testing repellents against *Aedes aegypti* (L) feeding on citrated blood through an artificial membrane is described. Repellents were applied at various concentrations on the membrane or in the blood, and the concentration required to give 50% repellency was determined. The percentage of mosquitoes that fed was affected by the time between anesthesia by carbon dioxide or cold and feeding. The second factor was not a critical one. When applied on the membrane or in the blood, diethyltoluamide was the strongest repellent, followed by dimethyl phthalate and ethyl hexanediol. Dimethyl phthalate applied on the membrane probably acted as a vapor repellent only. There were indications that blood acted as a vapor stimulant in feeding. Rabbits injected intravenously with diethyltoluamide did not repel the mosquitoes, nor did the blood taken from injected rabbits and offered through a membrane. It was concluded that the repellent was removed from the blood very rapidly.—Authors' abstract.

CONTROL OF MOSQUITO LARVAE IN LOG PONDS IN OREGON. Lewis, L. F. and Eddy, G. W. J. Econ. Ent. 52(2):259–260. 1959. DDT, heptachlor, and malathion emulsions at 1, 3, and 6 pounds of technical material per surface acre were used in tests for the control of mosquito larvae in log ponds in the general vicinity of Corvallis, Oreg. Protection against reinfestation ranged from 3 to 6 weeks for DDT, 5 to 10 weeks for heptachlor, and 2½ to 6 weeks for malathion. *Culex pipiens* L. was the dominant species in ponds in June and July: *C. stigmatosoma* Dyar predominated in August, September, and October. Except in the cooler months from October through May, *Culex tarsalis* Coq., *C. territans* Walker, and *Culiseta incidens* (Thompson) were represented by relatively small percentages.—Authors' abstract.

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REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO WORKERS AND MALARIOLOGISTS

HELEN SOLLERS
Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture

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Errata

In volume 18(3):271 of Mosquito News, section on Malaria—Plasmodia, change Brand to read Brandt. In 18(4):346, same section, under Carrescia and Arcoleo change 27(1/3) to read 37(1/3); in 18(4):343, section on Taxonomy, under Coluzzi, change 27(1/3) to read 37(1/3).

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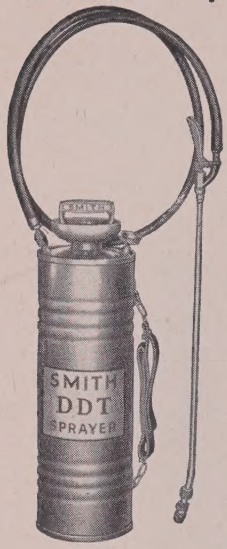

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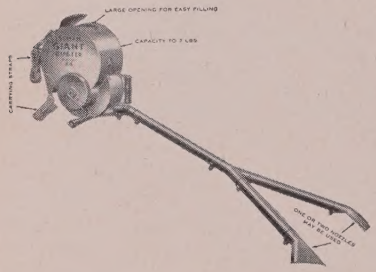

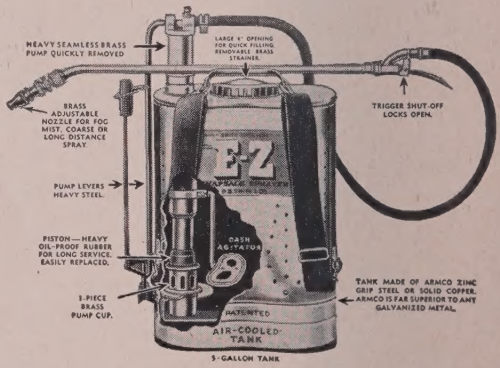
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